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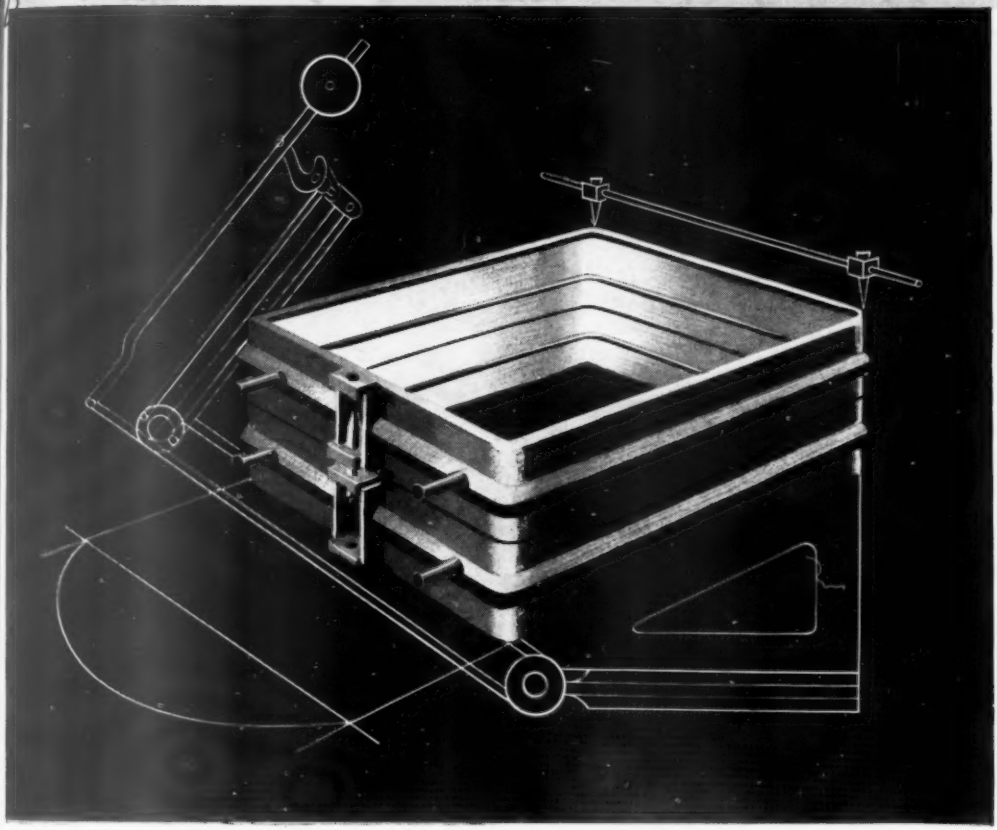

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Silicosis Claims

An important contribution to the legal aspects of claims for compensation by steelfoundry workers who have contracted silicosis, has been made by the publication of a booklet* by the Chartered Insurance Institute. The author, Mr. W. Sudren, is one of those interesting individuals who has made himself very familiar with the medical aspect of pulmonary diseases; steelfoundry practice; the Factory Acts and above all, the Common and Statutory Laws involved. He brings out quite a number of interesting points, as for instance, " The fact that dust has settled (on foundry walls) is indicative that the particles are heavier than air and the real danger is from the finer particles which continue to float in the atmosphere indefinitely." When pellets of grit escape from a shot-blast plant, another fallacy exposed is the allegation that it follows that dust must also be emitted—which cannot be the case, as the room is under suction, and " minute dust particles cannot escape by flowing in the opposite direction to the inrushing current."

Much evidence has been considered by the courts as to the Mark IV dust respirators. When it was first known to the industry was of cardinal importance; it was announced on August 20, 1938, and was approved in December of that year, but no mention of it was made in the annual report of H.M. Inspector of Factories for that year or later years. Since then (July, 1951) the Microfilter developed by the British Steel Founders' Association has received official approval, and these two are the sole respirators to be so approved. Reminiscent of the Counsel's query " Have you stopped beating your wife yet? " is criticism against the foundry owner as to the steps he took following the " First Report on Dust in Steel Foundries." If he tightened up his precautions, it could be taken as an admission that prior to that time the dust conditions were unsatisfactory. If, on the other hand, he did nothing, he could be accused of being indifferent to the safety of his workers.

The author's remarks on expert witnesses are certainly worth reading and acting upon. It is obviously difficult and well-nigh impossible to testify honestly as to the conditions operating in any particular foundry one, two, or more decades ago. Yet on such evidence, awards, which in the aggregate may well total to many hundreds of thousands of pounds, may depend. Legal traps baited for the unwary abound, which unless skilfully avoided may vitiate the true merits of the case. This booklet, which is a reprint from a paper read before the Chartered Insurance Institute, should be acquired not only by steelfounders, but by all who manufacture castings by the sand-moulding process.

* "A Guide to the Defence of Silicosis Claims made by Steelfoundry Workers," by W. Sudren, F.C.I.I. Published by the Chartered Insurance Institute, 20 Aldermanbury, London, E.C.2; price 2/- net.

Correspondence

FUME EMISSION FROM ARC FURNACES

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—An impression may have been gathered from certain statements in the pages of the JOURNAL that the problem relating to the emission of metallurgical fume from electric-arc furnaces constitutes one relating to the implementation of the Clean Air Act that has been solved. On the other hand, according to the evidence put forward to the recent Public Inquiry held by Sir Frederick Armer. the considered opinion of the whole of the steel industry, including manufacturers of rolled and forged products as well as steel founders, was that this problem has not yet been solved. The statements in the JOURNAL now called into question related to the extraction of fume and not its collection, which constitutes the real problem. Indeed it is well known that by applying suction to certain types of electric-arc furnaces there can result a substantial increase in the amount of fume emitted to the atmosphere. This arises from the possible indraught of air into the furnace chamber which results in additional oxidation of iron vapour within the vicinity of the arc. Furnace bodies and doors are not always completely sealed, and in any case operative conditions involve the opening of doors. Further, the maintenance of the necessary pressure of the furnace atmosphere required to reduce to a minimum the inleakage of air is not a simple matter. When one considers the question of the prevention of the emission of fume to the atmosphere a set of circumstances arises, which are entirely different from those taken for granted in any mere extraction of fume. Further, it is apparent that cases may inevitably occur in which the emission of copious fumes to the atmosphere is undesirable. Fundamentally, therefore, under all circumstances the most desirable solution of the problem is the prevention of emission of fume to the atmosphere, and this is one in which a completely satisfactory method of dealing with this fume has yet to be developed.

The real danger to the industry in the implementation of the Clean Air Act is that such statements may lead the authorities to think that these problems are easy to solve. Further, all sorts of local tinsmiths will be claiming that they can put matters right, whereas the opinion of those best able to judge is that such lines of approach inevitably fail in the long run and that the problem is one for proper research and development.—Yours, etc.,

R. J. SARJANT.

British Steel Founders' Association,
Broomgrove Lodge,
13, Broomgrove Road,
Sheffield, 10.
August 14, 1957.

DUST COLLECTION AT K & L

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—We have read with interest the article in the August 15 issue of the JOURNAL covering the new light foundry at K & L Steelfounders & Engineers, Limited, and we feel sure that these friends of ours would not object to us correcting a point in this article referring to the dust-collecting plant dealing with the knock-outs. This dust-collecting plant, which in addition deals with the return sand belt under the knock-outs, including the Rotoclone collectors, was designed and installed by us and not by Air Control Installations, Limited, who were responsible only for the supply of the Rotoclones to us.

The pneumatic sand-conveying plant dealing with the new sand from the rotary sand dryer was also designed and installed by us, whilst we also collaborated with the Hepburn Conveyor Company, Limited, of Wakefield, in the design and installation of the "Colhep" sand-cooling and desilting plant, with which firm we are joint patentees and manufacturers. —Yours, etc.,

W. L. GEE,
Managing Director.

Newton Collins, Limited,
Barford Street Works,
Birmingham, 5.
August 16, 1957.

Congress Paper Author

Mr. Bertil Thyberg, Author of the Congress paper, published on the facing page, who is chief metallurgist of Husqvarna Vapenfabriks, Sweden, received his M.S. degree in metallurgy in 1945 at the Royal Institute of Technology, Stockholm, Sweden. His first appointment was with Husqvarna Vapenfabriks AB as a foundry metallurgist. After 2½ years Mr. Thyberg moved to Sveriges Mekanförbund (The Association of the Swedish Mechanical Engineering Industries). In 1950 he rejoined his old firm, Husqvarna Vapenfabriks AB.

Chair of Metallurgy for Oxford

The establishment of a professorship of metallurgy at the University of Oxford will be made possible by a gift of £65,000; this was announced by the University on Friday, August 9. The generous donor is Mr. Isaac Wolfson, chairman and managing director of Great Universal Stores, Limited, and chairman of a number of other well-known companies in the distributive trades. The gift will be formally accepted in congregation on October 22, when it will be proposed that the new Chair shall bear the donor's name. The gift is an acknowledgment of the efforts which have been made for some years to raise the status of metallurgical studies at Oxford. It is considered that the professorship will be allocated to Nuffield College and that shortly after the formalities in connection with the gift, the name of the first professor will be announced.

Mr. FRANK G. STEINEBACH, in his Editorial in the (American) *Foundry* for August, says that from a selected cross section of foundries surveyed, it is estimated that the labour force will be increased by 6 per cent. by 1960. This figure is broken down and it is stated that these foundries will need 7 per cent. more patternmakers, 17 per cent. more hand coremakers, 12 per cent. more bench moulders, and 11 per cent. more floor moulders. On this basis, the Editor makes a clear case for intensive training to be carried out now.

THE VALUE of UK exports in July, at £281,400,000, was £5,500,000 more than in June. Last month's exports were equal to the monthly average in the first half year.

Progress in the Development of High-duty Malleable Cast Iron*

By Bertil Thyberg

Production of malleable cast iron in the Husqvarna concern, in Sweden, was limited, until 1951, to ferritic grades having tensile strengths in the range of 22.9 to 24.7 tons per sq. in., with elongation of 11 to 15 per cent. Developments in the production of high-duty malleable cast iron are detailed, both on laboratory and production scales, together with the effect of carbon, silicon and metallic alloying elements, and the application of special heat-treatments which enabled the tensile-strength range to be increased to 24.1 to 26.6 tons per sq. in. The Author concludes with details of the prevention of "inverse greyness" and the hardening of malleable cast iron.

Introduction

The production of malleable cast iron was commenced within the Husqvarna concern, more precisely at Norrahammars Bruk, as early as 1928. From the beginning and up to the summer of 1952, the production was wholly concentrated on ferritic-malleable cast iron, of the black-heart type. The minimum mechanical properties of this grade were specified at 22.2 tons per sq. in. tensile strength and 10 per cent. elongation, measured on an as-cast, unmachined test-bar according to ASTM's standard, *i.e.* a bar diameter of $\frac{5}{8}$-in. and a gauge length of 2-in. Even if the guaranteed minimum limits for tensile strength were not raised during the period stated, *i.e.* 1928 to 1952, this does in no way imply that development languished. In this connection, it should be sufficient to mention that in 1943 there was installed a semi-continuous gas-fired tunnel furnace with "pusher"-type conveyor cars for malleablizing. The annual capacity was 2,500 tons of castings, the total malleablizing cycle taking 128 hours. Compared with the then existing chamber-furnaces, this new furnace constituted an important step forward to more dependable and consistent heat-treatment results. One drawback with this large furnace unit, which was designed to accommodate the entire output of the malleable-iron foundry, was, of course, its reduced flexibility, *i.e.* the heat-treatment cycle was tied down. It is obvious that with a large semi-continuous tunnel furnace it is impracticable to work with different malleablizing cycles for different castings, which, however, is quite feasible for a heat-treatment plant comprising several smaller units of the bell- or muffle-type furnace. These considerations greatly influenced the choice of production methods for pearlitic malleable cast-iron.

From 1932 until 1947, the melting or white iron, for subsequent malleablizing, was carried out at Norrahammars Bruk in cold-blast cupolas. After lengthy investigations and numerous trial melts on a laboratory and pilot-scale plant, it was decided to instal 5.5 ton electric high-frequency furnaces, of ASEA's design, for melting malleable cast iron. This step was taken in order to obtain a closer control of composition, and hence quality, than is possible with cupola melting, even if this is carefully controlled. In addition, this step was intimately geared to the increased deliveries to the Swedish motor-car industry, where high demands of quality are stipulated.

In addition to improvement made on the production side, intensive research and development work has been carried out with the object of making, on a production scale, other higher-duty grades of malleable cast iron in addition to the well-known ferritic, malleable, of which, various grades were desired. The chief purpose of the development work was to raise the yield strength of the material, and also (but of subsidiary importance) the tensile strength, without excessive reduction of the toughness or machinability and, of course, without losing casting or heat-treatment properties. Before proceeding to deal, in more detail, with the progress of development, Table I (page 216) shows some typical mechanical data for the types of iron in the firm's malleable cast-iron production programme, that could be offered some 18 months ago, when it was decided to concentrate production, this resulted in the cessation of malleable cast-iron production.

As can be seen, grade A1 consists of the conventional grade of ferritic, malleable cast iron, a grade that occurs in the majority of national standards. Grade A9 is a very high-duty pearlitic malleable cast iron, having a yield strength almost twice that for A1. Ductility, considered as the elongation at fracture, remains satisfactory. Machinability is also acceptable, though naturally not equal with that for grade A1. Figs. 1 and 2 are micrographs showing typical structures for these two grades, Fig. 1 showing the temper-carbon particles embedded in a wholly ferritic matrix whilst for A9 (Fig. 2) the matrix consists of pearlite, the cementite of which is mainly in the spheroidized form.

Progression from Grade A1 to A9, or rather from a yield strength of 12.7 to 26.7 tons per sq. in., will now be discussed in more detail.

* Paper presented at the International Foundry Congress, currently being held in Stockholm.

High-duty Malleable Cast Iron

Influence of Carbon and Silicon

Even at an early stage, the possibility of enhancing the mechanical properties by decreasing the carbon content of white iron, as well as possibly increasing the silicon content was realized. On changing over, some 10 years ago, from cupola to electric high-frequency melting, the firm also attempted the above-mentioned idea on a production scale, but soon discovered that the increased shrinkage tendency, brought about by the change in composition, would require such a costly and laborious re-arrangement of the gating technique for castings, that it was found impossible to continue along those lines. Hence, the standard composition was reverted to and adhered to ever since, that is C 2.7; Si 0.95; Mn 0.3; S 0.06, and P 0.10 per cent. The malleable-iron charge consisted of only 5 per cent. (periodically 10 per cent.) of pig-iron, the remainder being made up of returns and steel scrap, carbon and silicon contents being adjusted with graphite or crushed coke and ferro-silicon respectively.

In order to detect the reason for the unsatisfactory ratio between yield strength and ultimate-tensile strength of the ferritic malleable iron, compared with that of a similar grade of American origin, experiments were carried out to establish the influence of silicon. A typical composition of American ferritic malleable gives lower carbon and higher silicon contents compared with the standard composition. In the one cwt. electric high-frequency furnace at the Husqvarna general laboratory, *ad hoc* experimental melts were produced having a constant carbon content (around 2.4 per cent.). The silicon contents were varied between 0.8 and 1.8 per cent., whilst contents of other constituents approximated to the firm's standard composition. Even with the highest silicon content, no primary graphite was obtained in the relatively light-section test-bars. This state of affairs was, of course, a prerequisite for the firm being able to draw any positive conclusions from the tests. The bars were malleablized with other castings in the large tunnel furnace at Norrahammar, being packed in the standard way in a mixture of spent and fresh iron ore. The annealing cycle employed was:—

Heating to 950 deg. C., about 42 hrs.; retained at 950 deg. C., about 22 hrs.; cooling to 950 to 800 deg. C., about 16 hrs.; cooling to between 800 and 700 deg. C., approximately 40 hrs.; and cooling to between 700 and 650 deg. C., for 8 hrs.

Table II (page 217) shows the results of mechanical tests on the malleablized test-bars, each value being the mean of three flawless tensile test-bars.

With regard to the mechanical properties given in Table II, it should be observed that conclusions of too extensive a nature ought not to be drawn from these relatively limited experimental data. It is considered, however, that a clear tendency for the ratio of yield strength to ultimate tensile strength to increase with increased silicon content can be established; this increase is connected with a relatively greater increase in the yield strength than in the tensile strength. The increase in the elongation values has been considered due in a large measure to the certain structural differences. In summarizing the results of this experimental series, the Author maintains that it is quite feasible to produce malleable cast iron with enhanced mechanical properties, in particular yield strength, by increasing the silicon content. One condition for introducing this measure in practice is the simultaneous lowering of the carbon content, in order to avoid primary graphite in the as-cast structure. However, with regard to the consequences of such a measure on the castability of the iron, this method for improving the mechanical properties was

FIG. 1.—*Ferritic-malleable cast iron (Grade A.1 × 500, etched with 2 per cent. Nital) shows temper-carbon particles in a wholly ferritic matrix.*

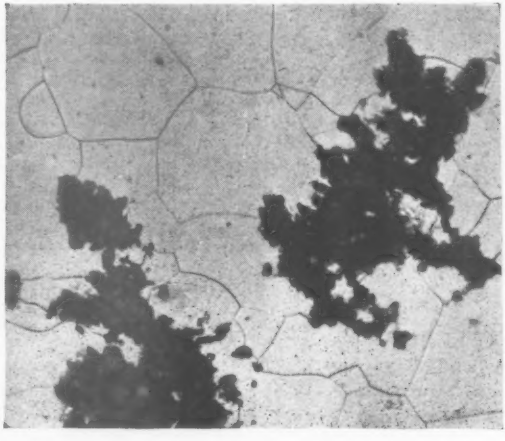
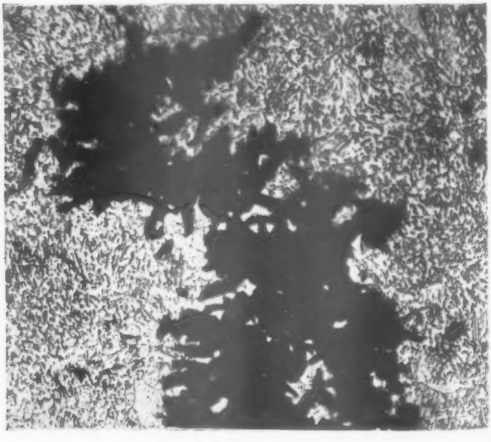


FIG. 2.—*Pearlitic-malleable cast iron (Grade A.9 × 500, etched in 2 per cent. Nital) temper-carbon particles embedded in a wholly pearlitic matrix.*



abandoned after production tests had been carried out.

Influence of Copper

Suggestions for increasing the mechanical properties by alloying the white iron with a metallic element were considered to be more feasible. From the start, a list of the following points was set up, these being regarded as desirable in a suitable alloying element, *viz.*: (*a*) The cost of the alloying addition must not be excessive; this implies that the element should either have a low price, or if high, its specific effect should be great. (*b*) The element should preferably be added in the ladle,

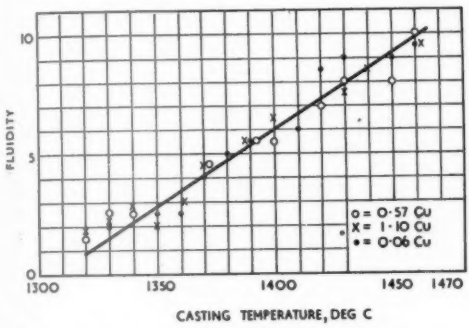


FIG. 3.—*Variation of fluidity with casting temperature, for three different copper contents, of* 0.06, 0.57, *and* 1.10 *per cent. Fluidity, in this case, being the length of flow, in inches, of a standard casting spiral* (*Sipp*[3]).

whereby only a lesser portion of the whole melt, from the 5½-ton high-frequency furnace, would be withdrawn for treatment. (*c*) The addition should not appreciably enhance the tendency for the iron to solidify in the grey state, *i.e.* it should not increase the risk of deposition of primary graphite. (*d*) The element should not, to any great degree, jeopardize the malleability of the iron. With regard to the pearlitic variants developed later, this stipulation might be limited to hold for the malleability at the first stage of graphitization.

The alloying element that, more than 10 years ago, first had attracted the firm's attention, was copper. Several interesting articles had previously been published in technical literature, *e.g.* by Long & Smith[1] and Elsea & Lorig[2] on the influence of copper. The beneficial properties attributed to copper as an alloying element in malleable cast iron may be summarized as follows: (*a*) The mechanical strength increases; (*b*) malleablization is improved. Copper aids graphitization during both first and second stage annealing, without enhancing the deposition of graphite; (*c*) Copper can easily be alloyed to white cast-iron, the alloying recovery being close to 100 per cent., and additions to even relatively small ladles create no difficulties; (*d*) Increased corrosion resistance and (*e*) Temper brittleness is countered. (This problem is sometimes apparent with hot galvanizing.)

At the beginning, the investigations were directed towards verifying the advantages accruing from copper addition; for this purpose, by alloying in the ladle (first on laboratory scale and soon afterwards on a production scale), test-bars and castings were produced with copper content ranging from 0.4 to over 1.5 per cent. The unalloyed base iron contained 0.05 to 0.10 per cent. of copper as an impurity.

The effect of copper was studied in the following sequence: Beginning with the molten iron, a rather comprehensive study was carried out of the influence of copper on the fluidity of white cast-iron. This series of experiments was commenced when the production of low-alloyed copper-containing malleable castings was in full swing. The fluidity was determined as the flow length of a spiral test-piece, according to Sipp[3]. This test has been used for a long time by the firm as a standardized fluidity-test in their foundries. From each ladle, with metal unalloyed as well as alloyed with copper additions, a whole series of fluidity tests was poured at successively decreasing temperatures, calibrated by means of an immersion pyrometer. The result is shown in Fig. 3. The fluidity (equivalent to the length of flow in inches) is set off as a function of the pouring temperature. From the diagram, it can be seen that so far as this rather rough measurement technique is concerned, no appreciable influence of copper on the fluidity can be perceived, either in a positive or negative direction.

Next, the effect on the tendency for primary graphite to separate during solidification was investigated. In the malleable shop at Norrahammar, the firm adopted as a routine check, a test cast 2-in. sq. section and about 6-in. long, moulded in green sand was fractured; any mottled structure would be seen in the fractured surface. Generally, only a few grey spots would be tolerated in iron to be used for motor vehicle castings. Fig. 4 shows the effects of varying ladle additions of copper, the top row representing a high-, while the bottom row a low-pouring temperature. The unalloyed test-pieces were wholly white, the shaded central part constituting a shrinkage porosity. With an addition of 1 per cent. copper, a few isolated grey spots appeared in the square test-block. Increasing the copper content to 1.58 per cent. had a powerful effect and resulted in this case in an unacceptable amount of free graphite in iron destined for somewhat heavy sections. Lorig and Smith[1] have published studies of this as is shown in Fig. 5, the copper content constituting a parameter. In addition, the diagram indicates the influence of section size and silicon content on the end structure.

The effect of increasing copper content on the mechanical properties, is shown in Fig. 6; four separate test series being represented. The test-bars from two melts were malleablized, being packed in ore in an electric batch-type furnace, whereas the other two melts were malleablized in the tunnel furnace at Norrahammar, along with castings from the current production. Only castings with

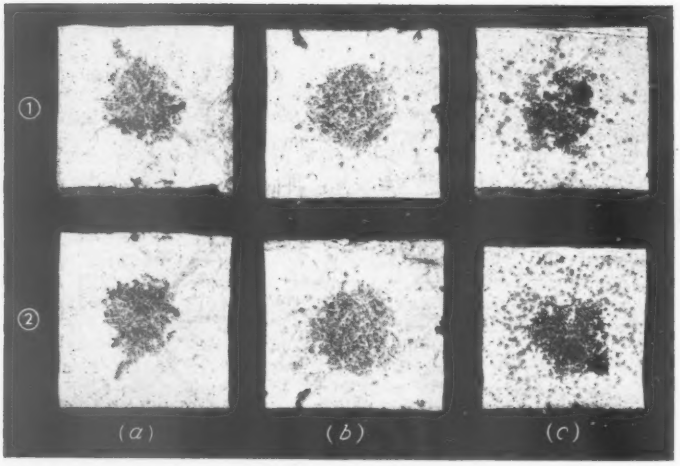


FIG. 4.—*Effect on the incidence of mottling in malleable cast iron with varying copper additions. Row 1 being cast at low temperatures and row 2 at high temperatures. (a) 0.07; (b) 1.0 and (c) 1.58 per cent. copper. The central shaded (dendritic) zone is the region of shrinkage porosity.*

a wholly ferritic structure were involved. The curves in the diagram clearly show a tendency towards increased mechanical properties with increasing copper content. Particularly marked is the influence on the yield point (measured as 0.2 per cent. proof stress) whilst the adverse effect on ductility (elongation) was relatively small. The results agree very well with what Lorig and Smith found, and published, for malleable cast-iron with a high as-cast carbon content, *i.e.* a composition very closely agreeing with the Author's firm. Series, corresponding to the ferritic malleable ones just described have also been carried out for pearlitic malleable. (These will be mentioned later.) At present it may be said, however, that the experimental values confirm the results already given.

In conformity with the effect of copper enhancing the tendency for cast iron to solidify in the grey state, there is also its beneficial influence on the speed of graphitization during malleablization; results show that for standard malleable-iron composition, one can estimate that with 1.0 per cent. copper lowers the malleablizing time, *i.e.* both first and second stage graphitization, by about 25 per cent. whilst Lorig and Smith mention as much as 50 per cent. for the second stage graphitization. In connection with malleablization, it must be observed that the alloying element in the concentrations under consideration at the moment (up to 1 to 1.5 per cent.) lowers the location of the pearlitic range, *i.e.* the range within which the austenite/ferrite/pearlite transformation takes place. In the case of wholly ferritic castings, it may be somewhat necessary to adjust the second stage graphitization temperature, to ensure a satisfactory result of the malleablization treatment.

Influence of Nickel and Molybdenum

Attention was also given to nickel as an alloying element in ferritic malleable some years ago, the reason being that the firm wanted to determine whether returns from nickel/magnesium-treated spheroidal-graphite cast iron could be used, without disadvantage, to make up part of the charge for melting malleable cast-iron. In particular, they were primarily interested to observe whether the low nickel contents concerned (not more than 0.3 per cent. Ni) would delay graphitization during the second-stage treatment, so that castings would not become completely malleablized. From a general point of view, they were, of course, also interested in determining whether nickel in these, or higher amounts, might be suitable as an alloying element for enhancing mechanical properties. To the first question the answer was that the low concentrations under consideration did not jeopardize the result of the malleable treatment in the tunnel furnace. With regard to the mechanical properties, it was shown that up to about 1 per cent., the specific influence of nickel was of the same order as of copper. As with copper, the increase in strength resulting from alloying was most marked on the yield point. Thus, alloying with nickel resulted in an increase in the ratio of yield strength to ultimate-tensile strength. Table III shows the average values of the test results obtained. The decrease in the tensile and yield strengths in the samples with the lowest nickel additions (0.3 per cent.) is rather curious, but most likely due to some experimental error.

TABLE I.—*Typical Mechanical Data for a Range of Malleable Cast Iron.*

Grade.	Matrix.	Ultimate tensile strength, tons per sq. in.	Yield strength, tons per sq. in.	Elongation, per cent.	Brinell Hardness.
A1	Ferritic ..	.. 22.9 to 24.8	12.7 to 14.6	11 to 15	110 to 130
A2	Ferritic ..	.. 24.1 to 26.0	14.6 to 16.5	9 to 12	115 to 135
A5	Pearlitic ..	.. 31.7 to 34.9	15.9 to 18.4	7 to 10	160 to 190
A6	Pearlitic ..	.. 33.6 to 36.8	19.0 to 21.6	6 to 9	165 to 195
A8	Pearlitic ..	.. 37.5 to 40.6	22.2 to 24.8	5 to 8	190 to 220
A9	Pearlitic ..	.. 39.3 to 42.4	24.1 to 26.7	5 to 8	195 to 230

Schneidewind and Reese[4] have published curves showing the effect of nickel on the yield strength. In Fig. 7 these findings are reproduced and the percentage increase corresponds fairly well with what the Author's firm found. Since nickel did not produce any specifically better effect than copper, it was not given any further attention owing to its price, scarcity, high melting point, and consequently, its inferior ladle alloying properties, etc.

Among elements that have been used in practice to enhance the properties of malleable cast iron, and in addition to the ones given above, Chubb[5] mentions molybdenum in amounts below 0.5 per cent.—increased strength with unimpaired ductility is assured. However, graphitization velocity, with a given silicon content, is stated to be substantially decreased. Four test melts were carried out in the firm's small laboratory melting furnace, with successively increasing molybdenum contents; after malleablizing, it could be reported that alloy contents of 0.3 and 0.5 per cent. molybdenum delayed both first and second stage graphitizations so much that the whole project with molybdenum additions had to be regarded as impracticable. The effect of the alloy, by allowing the castings to pass through the standard heat-treatment cycle in the tunnel furnace, was investigated and then microscopic determination of the amount of primary cementite and pearlite in the structure was carried out.

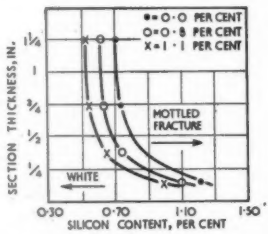


FIG. 5.—*Influence of silicon and copper content together with the section of a casting on the tendency for mottled-iron formation.*

Pearlitic-malleable Castings

In order to meet the demands of the motor-car industry, for mechanical properties still higher than those obtainable in ferritic malleable, even when alloyed with copper, the firm was faced, towards the beginning of the 1950's, with the necessity of producing castings with a pearlitic matrix.

Considering the melting and malleablizing furnaces available, it was planned to obtain a pearlitic matrix in the same base iron and with the same malleablizing cycle as was used for the ferritic grades. As is known, there are several fundamental methods of making pearlitic malleable, but owing to the layout of the production unit, the company were more or less forced to solve this problem by alloying the base iron. This should be brought about, preferably, by some addition agent in the ladle, whereby a suitable alloying element would be introduced, the effect of which should be to delay the formation of graphite during the second-stage graphitization, without appreciably influencing the course of the first-stage graphitization. Fortunately, there is such an element—manganese—and it is both cheap and efficacious for the above-mentioned purpose. Due to these qualities, it has for a long time been put to use as an alloying element in grey and malleable cast iron. The addition, of ferro-manganese, was made to the transport ladles while filling them from the 5½-ton furnaces, the ladles taking 10 cwt. of molten metal. For their standard pearlitic grade, classified as A5, a final manganese content of 0.75 per cent. was aimed at (as against 0.30 per cent. in the ferritic grade). The mechanical properties sought, in the first instance, were an ultimate tensile strength of 29 tons per sq. in. and a minimum elongation of 6 per cent., measured on the unmachined ASTM test-bar. Figures capable of being reproduced after the running-in period were 31.7 to 32.2 tons per sq. in. tensile, 15.9 to 18.4 tons per sq. in. yield point (0.2 per cent. proof stress) and 7 to 10 per cent. elongation, *i.e.* on the safe side of the stipulated requirements. Before having reached the stage of producing malleable castings on a full scale, the effect of different manganese additions, both on a laboratory and production basis, had been investigated.

TABLE II.—*Influence of Silicon on the Mechanical Properties.*

Silicon content. per cent.	Tensile strength, tons per sq. in.	Yield strength, tons per sq. in.	Elongation, per cent. on 2 in.	Ratio: Yield to tensile.	Brinell Hardness.
0.82	23.3	11.9	11.7	0.51	101
1.06	23.9	12.6	17.0	0.53	110
1.33	23.2	12.7	18.5	0.55	116
1.46	23.6	13.8	17.2	0.58	119
1.79	25.1	14.5	19.3	0.58	121

The graphs in Fig. 8, showing the tensile strength and the elongation as functions of the manganese contents respectively, constitute a summary of three trial melts on a laboratory and production scale during the running-in period. They illustrate both the general tendency of increasing tensile strength as well as decreasing elongation, at fracture, with increasing manganese content. As is well known, this phenomenon is dependent upon an analogous variation in the content of combined carbon in the matrix, this variation appearing as changes in the amount of pearlite. The heat-treatment was in all cases the same, *viz.* annealing in the tunnel furnace at Norrahammar. With the test-bars there were also cast various types of castings, which were subsequently subjected to deformation and hardness tests and structural investigations. The last has clearly shown that increased manganese content increases the tendency for the presence of residual cementite (*i.e.*, insufficient first-stage graphitization) in heavy sections. Some increased tendency towards the formation of primary graphite could also be seen, which was, in all probability, due to the inoculating effect of ferro-manganese addition in the ladle, the phenomenon being particularly noticeable when the ordinary ferro-manganese (containing 6 to 7 per cent. carbon) alloy was used. On

changing to low carbon ferro-manganese, which contains 1 per cent. carbon (maximum), conditions pertaining to primary-graphite formation improved appreciably. For a measure of safety, all heavy castings had small additions of tellurium (about 0.001 per cent.). This element gave no signs of unfavourably affecting the malleability of the iron, but, provided an efficacious remedy for preventing graphite formation. The graph shows the rather large variations in the properties of the pearlitic castings; in some measure, these variations may be occasioned by the lack of exactitude that is always inherent in an as-cast, unmachined test-bar. They may also be due to the method of production, *viz.* additions to a ladle. This involves uncertain-

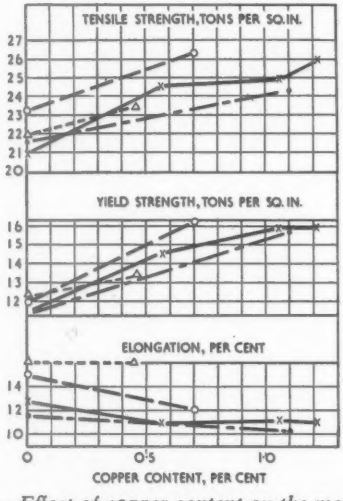


FIG. 6.—*Effect of copper content on the mechanical properties of malleable cast iron—ultimate-tensile strength, yield strength and elongation.*

ties brought about by varying amounts of molten metal in the ladle, by varying alloy recoveries and so forth. As mentioned previously, this grade of pearlitic-malleable gave a yield point (0.2 per cent. proof stress) of 15.9 to 18.4 tons per sq. in., and a Brinell hardness of 160 to 190. The structure of the matrix consisted of a mixture of ferrite and a varying amount of mainly lamellar pearlite. The micrograph (Fig. 9) shows a representative structure.

After having carefully followed up pilot runs of various castings (at the beginning of 1951) the firm undertook, towards the end of 1951 and beginning of 1952, the production of motor-car castings on a full-scale production, mainly for AB Volvo. The castings consist chiefly of parts for differentials, brake drums, etc. The Author claims that the company's pearlitic malleable satisfied the demands of the highly "quality-minded" customers as regards strength, wear resistance and even uniform and satisfactorily machinability compared with steel castings or forgings. The firm, however, was not entirely satisfied with machinability and ductility and attempted, by various annealing treatments, to spheroidize the cementite, by annealing at temperatures well below the critical range, those castings that after having been subjected to the first-stage graphitization were allowed to cool either rapidly (in air) or slowly (packed in boxes). Annealing temperatures between 675 and 725 deg. C. were tried. In all cases, the treatment showed itself to be completely ineffective as regards spheroidization, even with treatments lasting for several days. However, by applying a certain treatment, which is described later, they succeeded and at the same time, attained excellent mechanical properties.

Influence of Copper on Pearlitic-malleable Iron Alloyed with Manganese

The firm's customers in the motor-car industry did not remain satisfied very long with the pearlitic grade A5 which had been developed. Their demands moved up along the scale of mechanical properties. Most likely, their materials experts cast glances at what General Motors in the USA specified for similar parts. Naturally, they aimed at lighter designs and hence the weight reductions that higher-duty materials would allow. In their specifications, General Motors have a grade of pearlitic malleable which may be found in the 1955 ASTM Standard Specification No. A220–55T as "Grade 48004," which implies a minimum yield point of about 21 tons per sq. in. with at least 4 per cent. elongation. The company's A5 grade had, therefore, to have its yield strength improved by about 4½ tons per sq. in., without appreciably reducing the elongation. On being faced with this problem the results achieved with a ferritic end-structure alloyed with copper were considered. Trial melts with copper alloying of the pearlitic grade were made. The tendency was the same as that previously indicated for ferritic castings, *viz.* an increase in both ultimate tensile and yield strengths with increasing copper content while the elongation deteriorated only slightly. The percentage increase in the yield point is greater than that in the ultimate-tensile strength; tests showed that with a copper content of about 1 per cent., with a somewhat increased manganese addition, it should be possible to meet the stipulated demands on mechanical properties. In the autumn of 1953, the first trial shipments were ready and were completed according to plan. The base iron was the firm's ferritic grade A1, which was alloyed

TABLE III.—*Effect of Nickel on Mechanical Properties.*

Nickel content, per cent.	Tensile strength, tons per sq. in.	Yield strength, tons per sq. in.	Elongation per cent.
0.05	22.7	12.0	14.0
0.30	22.4	11.6	16.0
0.52	24.6	12.9	14.0
1.03	24.5	14.8	9.5

with manganese to a nominal content of 0.80 to 0.85 per cent. and with copper to about 1 per cent. The mechanical properties of "48004" were met. The hardness of test-bars and castings lay between 165 and 180 Brinell. The matrix consisted of pearlite with a maximum of 10 per cent. ferrite. However, it did not come to more than trial shipments, as before the results of machinability tests, etc., on the shipped castings were completed, another project arose, which made the development of grade "48004" less pressing. Before dealing with this, the Author wished to investigate "inverse greyness" that gave the company many "headaches," and had also troubled other makers of malleable castings, both at home and abroad.

Inverse Greyness in Malleable Cast Iron

As is well known, the composition selected for base metal (white iron) when making malleable castings is such that it is just on the point of solidifying grey. Expressed differently, the composition is made as soft as possible with respect to the danger of the formation of primary graphite in the castings. It is, of course, obvious that the composition must be suited to the sections in question. All this is perfectly natural and obvious to makers of malleable castings, as well as the fact that mottling may occur in heavy sections of the casting. To the contrary, and against all common sense, is the suggestion that in the same casting there may be a wholly white and satisfactory structure in the heavy sections whereas much lighter sections show mottling to a greater or lesser degree. This phenomenon does, however, appear. Likewise, it is sometimes possible to find untreated castings, in which an outer zone is grey while the central part is wholly white. This phenomenon was encountered in a disturbing measure in connection with part of a motor-car differential cast in manganese-containing pearlitic malleable, grade A5. Fig. 10*a* shows a casting complete with sprue, runners, atmospheric feeder-heads containing four blanks, the latter consist in principle of a heavy central section and a heavy ring, which are joined together by means of four channelled arms, whose cross-section is light compared with the other dimensions. Fig. 10*b* shows that mottling sometimes appeared in the outer layers of the light section of these arms. Logically, these ought to be the parts that cool fastest and in which there should be least risk of graphite formation. It should at once be obvious that this haphazard appearance of a graphite layer is exceptionally deleterious, from the point of view of mechanical properties, in particular, as the graphite always separates out as interdendritic envelopes. Therefore, considerable work was carried out to bring this phenomenon under control and thereby ensure first-class result. It would take too long to describe all the experiments carried out, and the Author would request leave to concentrate on the more important findings.

(1) Small routine additions of tellurium, as an inhibiting agent to mottling in heavy section, had already been made. Would an increase in the total amount added counteract this defect or would the addition concentrated to the critical sections give the same result? The first suggestion did not give a wholly effective result, but complete success was gained by dusting the cope cavity with tellurium powder. Even blacking the inner core with a special tellurium-containing wash of the firm's own make proved successful. Malleablizing treatments gave no indications of any adverse effects of tellurium, *i.e.*, provided this was kept under control and in reasonable concentrations, *i.e.*, less than 0.004 per cent. A possible solution was to paint the core with tellurium wash. However, a more facile and effective way out of the difficulty was found and hence, the tellurium wash was not employed on a large scale.

(2) An obvious explanation, lying close at hand, was to ascribe the inverse greyness to some inoculation effect from the mould wall. The coal-dust in the facing sand might be a producer of crystallization nuclei. Tests were carried out whereby the amount of coal-dust was decreased by increments right down to zero, without being able to notice any improvement.

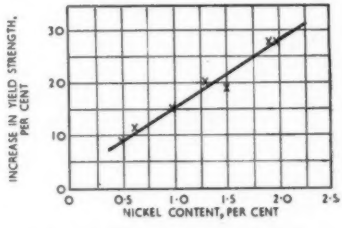


FIG. 7.—*Relationship between nickel content in malleable cast iron, and the increase in yield-strength.*

(3) Fig. 10*a* which illustrates a complete spray shows that every section was bottom cast. As the molten iron filled the mould cavity a large quantity of gas from the central core as well as from the mould in general would rush through the four arms. Perhaps this resulted in a deposition of carbon or carbonaceous material on the still relatively cool mould wall, where it would serve as inoculating nuclei and give rise to superficial graphite formation in the casting. In such a case, proper vents extending right down to the arms, from the upper surface of the mould, ought to lead off the gases and hence, remove the causes for such a deposition. Tests were made in this direction and were completely successful. The action of the vents was due not so much to the dissipation of the gases, according to the reasoning developed previously, but to a surprisingly effective cooling action by the small cooling pins that resulted when iron penetrated the vent to a depth of approximately $\frac{3}{8}$-in. It was shown that the same satisfactory results were obtained by placing a few pins on the pattern, roughly 0.2 in. dia. by 0.2 in. long. After casting, the pins could be removed without any trouble.

(4) In line with the experiments with the cast-on pins, tests were made by sprigging the mould walls

of the arms, in the cope, with flat-headed tacks, the heads thus coming to lie against the actual casting. The cooling action of these tacks eliminated the defect. This method was much more expensive and tedious than that indicated in section (3).

(5) It should also be mentioned that by casting in a dried mould, where both the core and the mould itself were made of material having a urea formaldehyde resin and cereal as binders, castings without any inverse greyness were obtained. On the other hand, they were abnormally brittle in the as-cast state.

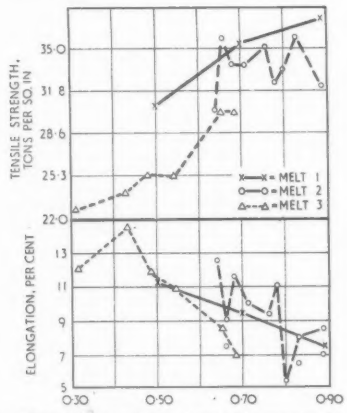


FIG. 8.—*Variation of mechanical properties (yield-strength and elongation) with increasing manganese content, for three test melts.*

As a remedy had been found, *viz.* the " pin technique " which could be applied when required, it is not necessary to point out that the size and number of pins had to be suited to the actual casting. However, the firm were not satisfied and still wished to discover the real reason for this defect. The problem was submitted to the foundry division of Sveriges Mekanforbund in the hope of having the question thoroughly examined. The assignment was handed to a committee, for fundamental research on cast iron where the Author had the privilege of acting as chairman with, among others, Prof. A. Hultgren of the Royal Institute of Technology and Prof. E. Rudberg of the Swedish Metal Research Institute as members. The working member, who in this case mainly pursued the problem, was Mr. Gustaf Ostberg, at that time attached to the foundry laboratory of the Association. Mr. Ostberg has, this year, published his more important findings in connection with the problem under discussion, both in British and Swedish technical literature and hence, mention will be made only of his more important observations.

(1) Inverse greyness is facilitated by such alloying elements as generally bring about grey solidification, *e.g.* silicon and aluminium, whereas such elements that have the opposite effect, *e.g.* sulphur and tellurium, reduce the incidence of inverse greyness.

In connection with this point, the Author would like to insert an interesting piece of information that was given by Morrogh and Hughes, of the British Cast Iron Research Association, during a discussion of foundry problems held in Stockholm in the summer of 1956. During the course of an investigation that they carried out on behalf of a producer of malleable cast iron in England, who was battling with problems similar to those of the Author, they noted that the tendency towards inverse greyness was eliminated by a small ladle addition of iron sulphide to malleable cast iron having a composition approximating to the nominal one of the firm's unalloyed malleable (grade A1) which has already been described. This A1 grade differs in that it has a relatively low-sulphur and an unnecessarily high-manganese content, in relation to the sulphur. (This manganese : sulphur ratio is consequent upon the composition of the charge). An increase in the sulphur (or a reduction in the Mn : S ratio) should completely cure the inverse greyness defect, according to BCIRA. To the Author's written inquiry whether the sulphur addition also had been efficacious with manganese-alloyed malleable cast iron, the reply was that a completely 100 per cent. cure had not been obtained.

(2) The tendency towards inverse greyness increases with increasing pouring temperatures.

(3) In order to check certain statements in the literature regarding the connection between the phenomenon of inverse greyness and segregation effects, careful spectrographic analyses of inverse-

TABLE IV.—*Heat Treatment Practice. Results Summarized.*

Treatment: malleabilized in tunnel furnace, and subsequently	Ultimate tensile strength, tons per sq. in.	Yield point, tons per sq. in.	Elongation, per cent.	Brinell hardness.
(1) 1 hr. at 850 deg. C., quenched in oil. Tempered for 1 hr. at 675 deg. C. . .	43.8	33.7	6	224
(2) 1 hr. at 850 deg. C., quenched in salt bath at 240 deg. C., held there for 30 min. and 1 hr. at 675 deg. C. . . .	45.0	30.8	5.5	218
(3) 1 hr. at 850 deg. C., air cooled to about 600 deg. C. Annealed at 710 deg. C. for 3 hr. . .	41.8	25.4	6	224
(4) As (3) above, but annealed for 5 hr. at 710 deg. C. .	41.2	24.5	8	222

greyness areas and white areas situated immediately below them were carried out. Nothing that could yield any definite clues came to light; all that was found was that small drops of metal enriched in phosphorus had penetrated to the surface of the test-pieces, *i.e.* a case of inverse segregation.

(4) Mr. Ostberg's most interesting and, at the same time, highly surprising observation is that under certain conditions, the superficial zone of the casting cools more slowly than the central parts at temperatures immediately above eutectic range. were verified by carefully performed temperature

measurements, in which all likely sources of error had been eliminated as far as possible. Immediately after the mould cavity is filled with molten iron, the surface layers cool at the highest rate, which is as expected. Since heat is conducted from the casting the temperature of the mould increases, the temperature gradient perpendicular to the mould wall decreases, with the result that heat conduction from the casting is retarded. However, heat flows to the surface layers of the casting from its interior at an only slightly retarded rate. The result can be that the cooling rate of the surface layers through the critical temperature interval is so low that graphite separates out. On the other hand, the central zone of the casting passes through this interval at a higher cooling rate since heat removal from this part has not been impeded, to the same degree, by the smaller fall in temperature across the area of contact between the casting and the mould.

Mr. Ostberg's theories, as outlined above, appear to give in certain cases, a satisfactory explanation of the incidence of inverse greyness. Any definite recommendations for counteracting this phenomenon beyond what has been found, during the course of their production-scale experiments at Norrahammar, are not described in this article.

TABLE V.—*Results Obtained from Heat-treatment Tests.*

Cooling rate between 850 and 650 deg. C., deg. C. per min.	Ultimate tensile strength, tons per sq. in.	Yield point, tons per sq. in.	Elongation, on 2 in. per cent.	Ratio, yield-point: tensile strength.	Brinell Hardness.
80	39.6	24.7	4.5	0.62	201
10	41.2	23.5	5.0	0.57	208
3	39.0	21.3	5.5	0.54	199
80					
No treatment at 710 deg. C.	45.6	34.5	2.2	—	265

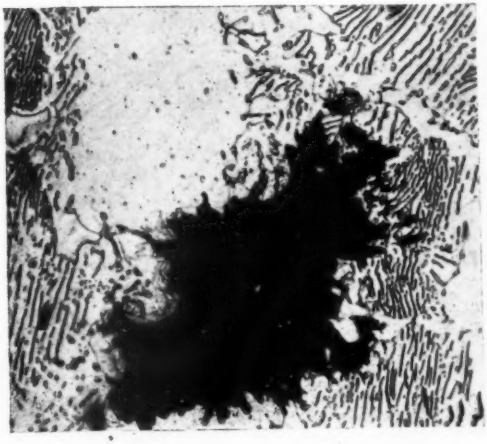
Each figure in the table is the mean of at least three test bars.

High-duty Spheroidized, Pearlitic-malleable Cast Iron

In the spring of 1954, the firm were asked whether they could undertake large shipments of malleable cast iron, the minimum mechanical properties of which were: yield point 23.5 tons per sq. in., elongation 5 per cent., Brinell hardness 187 to 241. It was not considered difficult to attain the yield point and hardness, but the stipulation of a simultaneous 5 per cent. elongation seemed to be beyond their "know-how." However, large orders according to Swedish standards were pending and the parts were few and rather easy, from a foundry point of view. Hence, the firm requested some time to consider their reply and test their resources and then commenced a large number of trial series, first on a laboratory scale and later, on a semi-production scale. After about six weeks of experimenting, often round the clock, sufficient basic data had been gathered, to enable them to reply that they could undertake to ship castings answering the stipulated requirements. In the course of the work, the firm had some help, both from information directly bearing on the problem and from castings made of the parts in question by an American manufacturer. What did the innovation consist of that had been arrived at and enabled them to advance their positions from the previous minimum yield of 24.6 tons per sq. in. and elongation of 4 per cent. to a minimum 23.5 tons per sq. in. and 5 per cent.? The answer to the problem was a heat-treatment process that gave a much more effective spheroidization of the pearlite than had generally been obtained. During the intensive research they found, in fact, several ways which will be described later, preference being given to the one that, for the firm, was the most practical. In order to be able to commence shipments within the time stipulated by the customer, existing furnace equipment within the concern had to be utilized. Any new installations of more suitable types of furnaces, etc., were not to be expected, at least not for the first shipments.

It appeared logical to start off, in the first instance, from some of the already existing pearlitic variants. A5 or A6, and to improve their properties by some additional spheroidizing treatment. It had been made clear to the Author's firm from numerous and tedious trials carried out previously that the introduction of an additional sub-critical

FIG. 9.—*Photomicrograph of pearlitic, malleable cast iron, improved with an addition of low-carbon ferro-manganese* (1.0 *per cent. carbon, max.*) *and* 0.001 *per cent. tellurium* (× 500 *etched* 2 *per cent. Nital*).



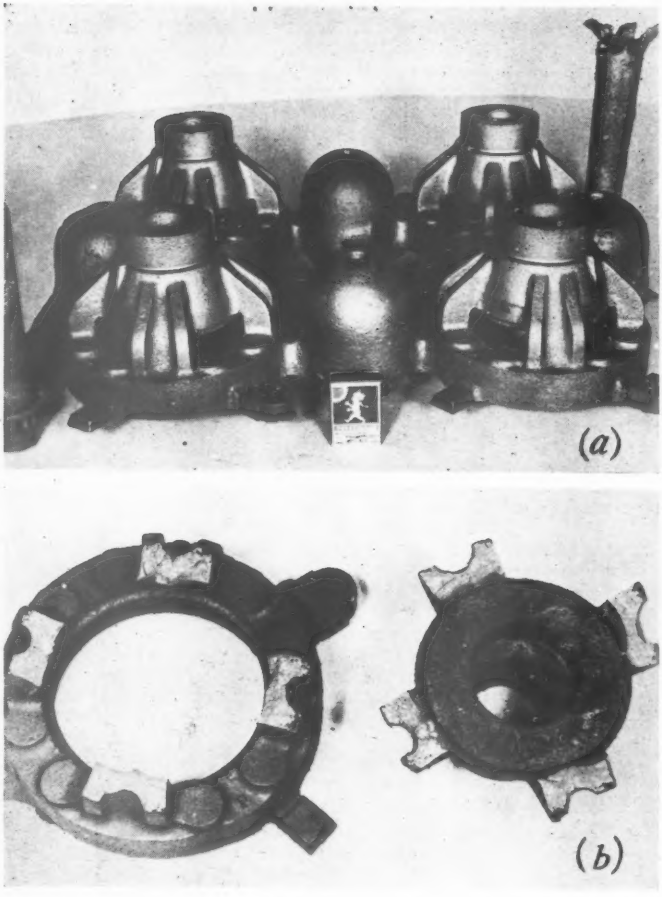


FIG. 10.—*Two views of differential gear-case castings in malleable cast iron. (a) Casting complete with feeder-heads, runners, sprues, etc. (b) a fractured casting, showing the location of zones of inverse greyness in the arms.*

annealing treatment was in vain. They were, therefore, aware of the necessity of reheating the castings to a temperature above the pearlitic range, in order to obtain the desired result. The first attempts consisted, therefore, of heating already malleablized parts of pearlitic A5 to 850 deg. C., holding at this temperature for one hour and then quenching in oil, followed by one hour's tempering at 675 deg. C. Table IV, which constitutes a summary of the more important test results, contain the mechanical properties of the oil-hardened and tempered test-bars. It is obvious that there is a wide margin of allowance, as regards the stipulated requirements. A similar treatment, consisting of quenching and holding for 30 min. in a salt bath at 240 deg. C., followed by air cooling and then tempering for one hour at 675 deg. C., gave a yield point of about 31.7 tons per sq. in. and an elongation in excess of 5 per cent. With regard to the oil-quenching treatment, the firm were somewhat sceptical on account of the obvious risk of cracking, with castings having irregular and complicated shapes. The salt-bath treatment is, from this point of view, decisively milder but is costly and difficult to carry out in practice. The question was, whether drastic quenching from the austenitic range was really necessary—would not air cooling suffice? Trial tests were carried out, in which test-bars were heated at 850 deg. C. for one hour, air cooled to about 600 deg. C., transferred to another furnace and annealed for three to five hours at 710 to 750 deg. C. The table shows clearly, that by annealing at 710 deg. C. for no more than three hours, hardness values of a suitable magnitude and approximately in the middle of the range in question were obtained — tensile properties being simultaneously attained. In order to check the results obtained, various test treatments were carried out on castings taken from current production of pearlitic malleable. Subsequently, checks on hardness, strength and microstructure were performed. The results were consistently satisfactory, particularly when copper-alloyed pearlitic grade A6 as base material was used. The micro-photos give an indication of the radical change in the constitutional structure of the matrix, brought about by the additional heat-treatment. The basic material had a matrix structure consisting chiefly of lamellar pearlite and a varying amount (20 to 40 per cent.) of ferrite (see Fig. 9). After being subjected to additional heat-treatment, the structure was wholly pearlitic and the newly-formed pearlite was extraordinarily well spheroidized, the structure consisting almost wholly of cementite spheroids embedded in the ferritic matrix (see Fig. 2).

When full-scale production was commenced, in December, 1954, of this new grade of malleable cast-iron, the firm followed treatment 3 in Table IV, *i.e.* after malleablization in the tunnel furnace, the castings were subjected to a solution treatment at 850 deg. C., followed by air cooling

and a three-hours anneal at 710 deg. C. For this treatment, the electric chamber furnace was utilized in the heat-treatment section at Husqvarna, these furnaces being normally used for pack carburizing. Continuous production control was carried out by means of test-bars which accompanied the castings during the entire treatment, during both malleablizing, in the tunnel furnace, and the additional annealing. The hardness of the actual castings were checked prior to shipment; for closer control, including microstructure, hardness and strength, a few individual castings were picked out as random samples; characteristic data taken from the production reports for grade A9 is given in Table I.

It was gradually decided to procure a separate electric malleablizing furnace suitable for this high-duty material; consultations with Swedish furnace makers were initiated this soon led to the purchasing of a large electric bell-type furnace, with a charge capacity of about 3½ tons. The object was to carry out the malleablization in this furnace; the castings would be piled or lying freely in perforated containers. A suitable heat-treating cycle was tried out on a laboratory and semi-production scale. Satisfactory results were obtained from the following treatment:—(1) Ferrite-stage graphitization at 950 deg. C. for 25 hours; (2) cooling of whole charge freely in air to 650 to 700 deg. C.; (3) reheating to 850 deg. C. and holding at this temperature for one hour; (4) rapid cooling in air to about 650 deg. C. and (5) final anneal at 710 deg. C. for three hours.

TABLE VI.—*Influence of Tempering Temperatures on Hardness.*

Tempering temperature, deg. C. ..	Untempered	300	400	500
Hardness	55	49	40	32

(Samples in every instance quenched in oil from 850 deg. C.)

Cooling Rate in Spheroidization

During the course of the test runs, it was found that the rate of cooling down to 650 deg. C. subsequent to reheating to 750 deg. C. had a great influence on the outcome as regards the final structure and the mechanical properties resulting. This led the firm to undertake a separate investigation into the effect of this factor. Test-bars of the pearlitic manganese-alloyed grade A5 were reheated to 850 deg. C., being packed in a box containing sand. Some bars were removed from the box and were allowed to cool freely in air to 600 to 650 deg. C. The fall in temperature was registered, by means of a thermocouple, and was found to be about 80 deg. C. per minute; the next variable was obtained by allowing the whole box and contents to cool in air. This gave a cooling rate of about 10 deg. C. per minute. The lowest cooling rate was obtained by having the box containing the bars enclosed, during the whole heat-treatment, in an outer container with insulating material in between. On being allowed to cool outside the furnace, a cooling rate of about 3 deg. C. per minute recorded. After reaching 600 to 650 deg. C., the bars were then subjected to a three-hours treatment at 710 deg. C., whereupon they were examined, with respect to tensile, hardness and structure. For comparison a few bars from the batch subjected to the highest cooling rate were included; these bars had not been given any spheroidizing treatment at 710 deg. C. subsequent to the air cooling. From data contained in Table V, it is clearly evident that an enforced cooling, equivalent to at least 10 deg. C. per minute, is a prerequisite to obtaining effectual spheroidization of pearlite during the subsequent heat-treatment. In addition, a high yield point (more correctly expressed as a high ratio of yield point to ultimate tensile strength) is apparently brought about by rapid cooling prior to the final heat-treatment.

Hardening of Malleable Cast Iron

Hardened malleable cast iron has great potentialities to offer when it comes to producing a material having extraordinary wear-resistance. General Motors in the USA who, with their so-called Armasteel have proved the excellent properties of malleable cast-iron in this respect. In Sweden, Overums Bruk have introduced hardened, malleable-castings as wear-resisting parts in agricultural machinery, bulldozers, etc.; the firm also occasionally supplied parts in hardened malleable cast iron. In order to determine which hardnesses, and which tensile properties, were attainable in this way, a large number of quenching and tempering tests were carried out both with ferritic and manganese-alloyed castings. As expected, the best and most consistent results were obtained with pearlitic malleable. Prior to heating and quenching, this material contains carbon in the form of graphite and cementite evenly distributed throughout the matrix. The austenite quickly dissolves the necessary amounts of carbon since the diffusion paths are short. In the case of wholly-ferritic material, in which only the rather sparsely distributed temper-carbon nodules can supply the austenite with carbon, heating to quenching temperature is more tedious and troublesome.

With flame or induction hardening, in which extremely short heating times are involved, a wholly pearlitic matrix is a prerequisite to a satisfactory final result. When hardening the whole part, a solution temperature of 85 deg. C. was used, followed by quenching in oil. When using brine as a quenching medium, a greater amount of residual austenite was obtained than with oil quenching, with a consequent lowering of hardness in the as-quenched, untempered state. In Table VI, the influence of tempering temperatures on the hardness obtained can be seen.

Acknowledgments

Finally, the Author wishes gratefully to express his thanks to the management of Husqvarna Vapenfabriks AB for permission to publish the findings given in the Paper. In addition, the Author would like to thank sincerely all his colleagues engaged in the development work, and particularly Mr. Olaf Goransson and B. O. Sjöblom and Å. Thiberg.

(*Concluded at the foot of first column, Page* 224)

Foundry Technology Developments

"Recent Developments in Foundry Technology" is to be the theme of a symposium to be held from February 5 to 8, 1958, at Jamshedpur, India. It is being jointly organized by the National Metallurgical Laboratory, the headquarters of which are located in that town, and the Indian Institute of Foundrymen. An exhibition, depicting the present stage of Indian foundry industry in relation to future expansion plans is to be staged in the laboratory. The symposium will cover the following subjects: (*a*) Raw materials for moulds and cores; (*b*) materials and methods for fettling and handling materials in the foundry; (*c*) innovations in foundry technology *i.e.*, CO_2 Process and shell moulding; (*d*) developments in melting including casting techniques and latest equipment; (*e*) recent developments in the founding of ferrous and non-ferrous metals and alloys; (*f*) the position of the foundry industry in India *vis-a-vis* its second five-year plan; (*g*) foundry mechanization and layout; and (*h*) foundry management.

Invitations are being extended to technologists and scientists in all part of the world, to contribute technical papers to the symposium, and those wishing to do so should indicate this to Dr. T. Banerjee, National Metallurgical Laboratory, Jamshedpur, 7, India.

New Company

Edgar Allen & Company, Limited, together with their agents Noyes (Australia) Proprietary, Limited, announce the formation of a company to be known as Edgar Allen Noyes Pty., Limited, to carry on the business of specialists in heat-treatment and hobbing. The registered office of the company is 360, City Road, South Melbourne, S.C.5, Australia, and its works are situated at 148a, Thistle Thwaite Street, South Melbourne, S.C.5.

The first directors of this joint venture are Mr. J. H. McDonald, of Noyes (Australia) Pty., Limited; Mr. B. B. Green, director of Edgar Allen & Company, Limited (with Mr. R. Oldham of Melbourne as alternate); Mr. J. L. Lee and Mr. P. J. Glenn who is also secretary to the new company.

Progress in the Development of High-duty Malleable Cast Iron

(*Continued from page* 223)

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National Foundry College

Summer Visit to the Continent

This summer, students of the National Foundry College went, for their annual series of visits, to foundries in Belgium and Germany. A whole week was spent in this way, the party arriving in Liége on a Sunday, and on the Monday morning visiting the Societé Anonyme Cockerill-Ougrée. That afternoon, they proceeded to Campagnie Generale des Conduites d'Eau, and afterwards travelled to Germany.

On their first evening in Germany, the National Foundry College party was received by Professor Dr. Ing. W. Patterson at the Hotel "Postwagen" in Aachen, and an extremely pleasant time was spent in the company of the Professor and his colleagues from the Aachen Technical High School. On the Tuesday, an inspection was made of the Giesserei-Institut, Aachen, where a guided tour of the extremely well-equipped premises provided there for foundry training and research was arranged for them. On Tuesday afternoon, the Phoenix Foundry at Mulheim-Meiderich was visited. The Krupp foundries in Essen and the Villa Hugel were the objectives on the Wednesday morning, and during the afternoon the party was received at Heinrichshütte in Hattingen. Next day, August-Engels in Velbert was visited and after luncheon the party proceeded to the radiator foundries of Eisenwerke, Hilden. On the Friday, the party proceeded to the Bergische Stahlindustrie at Remscheid, and in the afternoon the last visit of the series was made to the non-ferrous foundries of J. G. Schweitzke in Düsseldorf. The party returned home to England on the Sunday.

This is the first foreign visit which has been made by the National Foundry College and very many interesting features were seen. Great hospitality was extended to the party throughout the week and students and staff are greatly indebted to Professor Patterson for the excellent arrangements made on their behalf in Germany.

Pre-apprentice Training School

The Scottish Region of the British Transport Commission is now operating a pre-apprentice training school at 348, Parliament Road, Glasgow. It is designed to teach the elements of fitting and assembly; machinery; smithing; electrical work; welding; moulding; sheet-metal work and copper smithing; pattern-making; joinery and coach finishing; plating; trimming; painting and polishing. The foundry section is quite simple in its equipment and has four moulding benches, a Morgan paraffin-fired crucible furnace, an electrically-heated core-drying oven, and the usual hand-tools of the trade. Aluminium castings are made in green sand and foundry processes and terms are explained. The course lasts four months and the apprentices work 38¼ hours a week, of which 62 per cent. is spent in practical work and the balance in class rooms, continuing their general education with a bias towards technology. The pre-apprenticeship course finished, lads enter mainly the railway repair shops where ample opportunity is afforded them to become skilled craftsmen.

STEEL PRODUCTION IN CANADA for the half year touched a new record at 2,600,000 ingot tons, a rise of 2 per cent. on the total for the period January—June, 1956. Pig-iron output was 11 per cent. higher at 1,900,000 tons.

Phosphor Bronze Company's Extensions

New Production Shop and Office Block at the Birmingham Works

At the end of June, extensions and new offices were formally opened at the Bradford Street, Birmingham, works of the Phosphor Bronze Company, Limited (one of the Birfield, Limited, group of companies). One reason given for the expansion, of which the sections just completed are only a part, is the compulsion engendered by having 12,000 customers currently "on the books." Certainly, the writer knows of no other foundry producing castings in so many alloys by so many processes. It is claimed that over 100 copper-base alloys are in regular production and in addition to dry- and green-sand moulding in all weights (up to 10 tons), centrifugal casting is widely practised, continuous casting of rods and sections has been developed, and the CO_2, shell-moulding and Shaw processes are being extensively applied.

In addition to non-ferrous alloys, the new extensions cater for growth of the alloy-steel and heat- and creep-resisting alloy castings production, the metal being melted in a range of high-frequency electric furnaces. Copper-base ingots, white metals and aluminium-alloy ingots are made to specification for outside sale, as are two grades of phosphor-copper and various grades of nickel silver shot. The total production of ingot and cast metal approximates 75 tons per week and the number of castings reaches the astonishing total of 18,000 weekly. A view of the

Fig. 1.—Facade of the new office block erected by Phosphor Bronze Company, Limited, as a frontage to their works in Bradford Street, Birmingham.

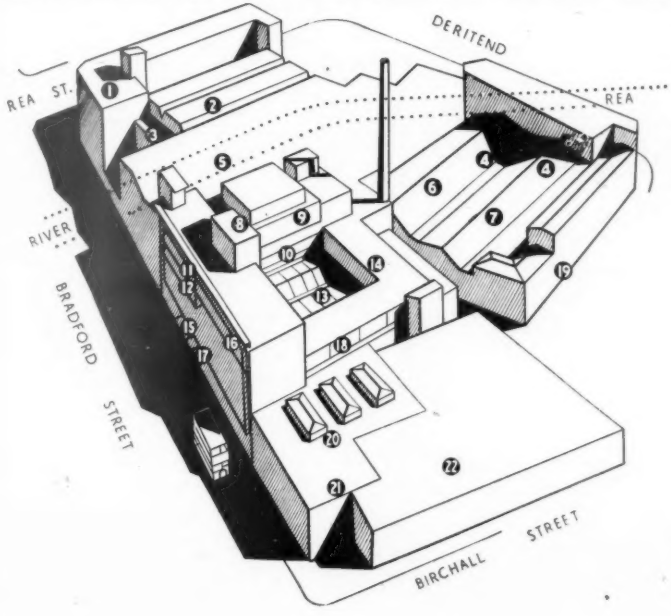

Fig. 2.—Perspective sketch of the premises of Phosphor Bronze Company showing the location of the various departments.

Key: (1) Area for future development; (2) steel foundry; (3) River Rea extension; (4) stick brass shop; (5) general foundry; (6) ingot shop; (7) centrifugal foundry; (8) main stair and lift; (9) (2nd floor) works canteen; (10) patternshop; (11) (3rd floor) staff canteen; (12) (2nd floor) kitchen; (13) machine shop; (14) planning office; (15) (ground floor) managing director's office; (16) (3rd floor) directors' suite; (17) main entrance; (18) general office; (19) laboratories; (20) machine shop; (21) inspection department; (22) neighbouring factory.

Fig. 3.—Battery of centrifugal casting machines of the horizontal type. Small and large ring castings (up to 3½ tons individual weight) are also produced on vertical-axis centrifugal casting machines.

new office block is shown in Fig. 1, while Fig. 2 shows a perspective presentation of the layout of the various shops. Figs. 3 to 7 show views of the production departments.

The official opening ceremony was performed by the Very Rev. C. G. St. Michael Parker (Suffragan Bishop of Aston), and a dignified plaque in the reception hall records this fact—thought to be almost unique in the annals of foundries.

Expansion Plan

Difficulties in obtaining sites and building licences led the company to purchase premises adjacent to the existing works, which could be adapted to requirements. For these premises, a master plan was required from which stage by stage the transition to a modern foundry could be achieved. Towards this end, the building alterations had to be so arranged that the ground-floor bays were available first for production purposes, and the canteens, shower-baths, washroom and cloakrooms block, offices, etc., followed as licences became available. The main objective in planning the buildings was the need for the provision of as large and level a ground-floor area as was possible, for foundry and heavy production work. For this reason, also, all equipment, such as fans, fuel and other stores, have either been placed underground or above working level.

The works cloakrooms and shower-baths, etc., are on the first floor, centrally placed, as are the mould-making areas and patternshops. The offices and canteens are placed on the second, third and fourth floors, enjoying the amenity of extra sun and air, without interfering with production space. For the purposes of the opening day, when there were tours by customers, the technical Press and other friends of the company, space was reserved on the third floor for an exhibition of the firm's products. Here, a most impressive array of 250 different items was arranged, including a display of "Birflo" valves and vacuum brake equipment which the firm produces as finished-goods lines.

Internal Transport

To aid flexibility of production and easy and quick movement of all kinds of traffic, walls and other obstructions were removed wherever possible in the existing buildings, and all the ground floor was brought to one level. In the new buildings, roof and crane supports have been limited for the same reasons. To facilitate trucking—necessary to reduce internal transport costs—sand floors in the foundry have been abolished and replaced by concrete. Considerable attention has been given to the layout of the various departments and their plant to reduce internal traffic to a minimum.

Cloakroom, lavatory and shower-bath accom-

Fig. 4.—Pouring in progress in the shell-mould section of the Phosphor Bronze Company's foundries. A repetition line here is copper-base tube-fittings.

Fig. 6.—Section of the repetition sand foundry, where the majority of the moulds are machine-made and "banked" on roller conveyors for pouring.

modation for all employees has been built, providing each worker with an individual locker and giving sufficient showers adjacent to the locker-room to enable all who wish to use this amenity to do so before leaving the factory.

Administration

The office accommodation is built in four tiers against the Bradford Street facade of the main foundry. On the ground floor, only sufficient space is taken for the entrance-hall, lifts and staircase, together with inquiry and interview rooms and the managing director's office, the latter having direct access to the foundry. The main suite of production offices are at first-floor level; the accounts offices, main works canteen and kitchen at the second-floor level and above these, on the top floor is the staff canteen and the director's suite and boardroom. (The exposition of the firm's products displayed on this floor, and referred to earlier, has proved so valuable for proving at a glance the immense range of foundrywork undertaken, that it may be retained as a permanent feature.)

Fig. 5.—Shell-mould "biscuits" for producing body castings—with a complex core structure—for a submersible pump. The castings are produced in 85/5/5/5 gunmetal alloy.

Future

Possible future expansion has been catered for adequately. A substantial amount of property, mostly derelict at present, on the far side of the River Rea (which is already spanned by the present extension buildings) has been bought and, with the approval and assistance of the Birmingham City engineer and surveyor, the factory has been extended above the river level to form the link with the future building work. (This was an engineering feat involving bridge girders, 65 ft. long, each weighing 35 tons.) It will enable the existing floor-space to be doubled without changes in level of the main area.

Employee Amenities

In addition to the cloakroom, shower-bath and canteens already mentioned, employees at these works enjoy several other amenities, including pension and shareholding schemes, organized training for promotion within the Phosphor Bronze Company and its associated companies, sports and recreation clubs, full medical services on the premises and safety and welfare organizations.

Birfield Residential Education Centre

Those privileged to visit the extensions of the Phosphor Bronze Company on the opening day were also taken on a coach trip to inspect the residential industrial education centre which the Birfield group maintains at Goldicote House, Stratford on Avon (Fig. 8).

Birfield, Limited is a group of engineering companies (including the foundries of Phosphor Bronze Company and Kent Alloys, Limited) all concerned with the manufacture and processing of components and equipment for a wide variety of industries. The companies within the group help each other in many information and training facilities. Each company,

Fig. 7.—Battery of rotary and tilting furnaces in the ingotting department. (Phosphor Bronze Company.)

however, operates individually although there are ways and benefit especially by pooling research, co-ordinating group committees, with differing functions. One of the first of these to be formed was the Birfield Education and Training Committee consisting of a director from each company.

Goldicote House, situated four miles south of Stratford on Avon on the Banbury Road, was built between 1830 and 1837 on the site of a much older building. One of its previous owners was Chas. Joliffe, whose crest is to be seen above the door in the stained glass. The motto displayed there, *Tant que je puis*, ("To the best of my ability") has been adopted by Birfield as an inspiration to those who use the premises. The principal activity nowadays at Goldicote House is the running of residential conferences, there being 26 beds available. A housekeeper and residential staff provide facilities and ensure service of a standard comparable with a first-class hotel.

There is an executive committee, responsible for co-ordinating the group education and training policy implemented at Goldicote House, which consists of the education and training officer or personnel officer of each company with the chief education officer as chairman. This committee considers the implementation of group policy and draws up detailed schemes either for co-ordinating activities within separate companies in the group or for operating on a group basis as may be considered appropriate. In particular, the Birfield Committee discusses the programmes to be followed in the various conferences held at Goldicote House and deals with the allocation of conference places amongst the personnel of the companies. Other specialists visit Goldicote House to speak at the conferences, and local colleges—in particular the Birmingham College of Technology (Department of Industrial Administration)—assist in providing lectures. Directors and senior executives from various companies in the group talk on their own special subjects from time to time and, frequently, members of the Birfield board of directors give talks. The remaining sessions are conducted by the instructional staff at Goldicote. Conferences of all directors, normally led by the chairman of Birfield, Limited, are held yearly. All managers visit Goldicote each year, either for a three-day conference, or on three of four shorter conferences, and foremen's conferences covering five days are held; all students and graduate apprentices within the group attend one two-day conference each year, while craft apprentices attend once or twice during their apprenticeship.

Schemes Applied

Under the general direction of the Education and Training Committees, the schemes co-ordinated

(*Concluded at the foot of first column, on Page* 229)

Fig. 8.—Goldicote House, Stratford on Avon, the residential conference and training centre of the Birfield group of companies.

Passing of the old-time Mangle

The Co-operative Wholesale Society's iron works at Keighley closed down at the end of last month. About a dozen foundry workers are affected, "they are being treated very generously" said an official of the Society in Manchester recently. The production of castings in this foundry was mainly of the old-type mangles and wringing machines chiefly assembled from castings. Heavy and cumbersome, they were now completely outmoded, and there was no further call for that class of work.

Half a century ago, Keighley and district was the hub of the wringing-machine trade and several foundries made little else but components for these. Plate moulders would put down a "street" at threepence-halfpenny a box; gear-wheels at three-halfpence for four, three-tier "specials" at threepence each, moulded teeth worked loose-pattern, and they had to "mesh as cast" or "file 'em yourself." The entire machine could be purchased (ex-works) for 25 shillings (with lignum vitae rollers five shillings extra).

To-day, a modern streamlined unit, clamped to the kitchen sink, will do with ease what required in those spacious days two brawny hands on the flywheel's twelve-inch handle, to churn and almost disintegrate fustian, flannel, and other textiles, fashionable, at that time—garments that came out in endless monotony, from a seemingly bottomless tub as from a conjurer's hat, or so it seemed to the schoolboys whose playtime was curtailed for lending a hand at the wheel.

The hard-wood rollers of these old-time mangles, after that "extra turn of the screw" for tension (and maybe punishment), would flatten metal buttons most effectively, and the current fashion of two-hole bone buttons came out on the far side in pieces. One machine to a row of houses was not unusual in those days and the owner was always a popular neighbour. The card in the window, "Mangling done Here," was not just a "Casey Court joke," it was a fact. Any member of a large Victorian family, who can tear a pack of cards with ease would, if truthful, probably admit that he developed his extraordinary grip by "hand-wringing" half a dozen voluminous red-flannel underskirts before going to school.

Phosphor Bronze Company's Extension

(*Continued from page 228*)

from Goldicote House include: recruitment and training of student and graduate apprentices; training of craft and technical apprentices; apprentice conditions in general; the apprentice training centre being established in Birmingham; the Birfield university scholarships schemes; induction training and employee handbooks; records of training, etc., and educational advice; liaison with colleges, national bodies and professional institutions; textbook and reference library; training of foremen and supervisors (incorporating the Training Within Industry scheme); training of managers; promotion schemes, and information for management (including a management manual). In addition, the assistant education officer and the technical education officer also visit the smaller companies which are not large enough to have their own education and training specialists.

Villiers-JAP Fusion Proposed

An offer to J. A. Prestwich Industries, Limited, from the Villiers Engineering Company, Limited, for the fusion of the two companies is recommended for acceptance by the board of Prestwich Industries. It is pointed out that the two companies manufacture similar types of engines and, but for the present proposals, would have to spend considerable sums independently on design, development, tooling, and sales, involving much duplication of expenditure.

Considerable economies would result from the fusion and both companies would be put in a better position to compete in home and overseas markets. The individuality of JAP would be preserved and its separate identity and name would be retained. Shareholders can opt to take one fully paid 5s. ordinary share in Villiers or 11s. 6d. cash for each 5s. Prestwich ordinary share held. The arrangement will cost Villiers £148,720 in ordinary shares and £577,944 in cash.

The Prestwich directors and certain other members of the Prestwich family, have conditionally agreed to accept in respect of their aggregate holdings of 1,057,119 shares, approximately two thirds of the total.

A. V. Roe Canada Bids

After weeks of rumours and denials, it was revealed on August 9 that A. V. Roe (Canada), Limited, a holding subsidiary of the Hawker Siddeley Group, Limited, has made a bid for control of the Dominion Steel & Coal Corporation, Limited, of Canada. The offer, if accepted in full, would involve more than $110,000,000 (about £39,000,000) including £30,000,000 (£10,070,000) of cash.

Mr. C. B. Lang, president of Dosco, announcing the bid, said that A. V. Roe stipulated that it must acquire 1,600,000 shares, or about 52 per cent. of the shares outstanding if all Dosco debentures are also converted. Some legal requirements would still have to be met, but the formal offer would be made not later than the end of August and would be open for 30 days.

The terms of the offer are:—1¼ Avro common shares, plus $10.25 cash for each Dosco share; 31¼ Avro common shares and $199.75 cash for each Dosco $500 4 per cent. convertible debenture; 68¾ Avro common shares and $574.46 cash for each $1,000 4¼ per cent. convertible debenture.

This is the second time in four months that A. V. Roe has moved to buy into a steel-producing company. Last April the company bought 150,000 shares of the Algoma Steel Corporation stock for about $15,000,000.

Dosco and its subsidiaries stretch from Windsor, Ontario, to Newfoundland, and employ about 30,000. A record net profit of nearly $7,050,000 last year was reported by Dosco and 23 of its subsidiaries. This did not include figures for 10 other subsidiaries and associated companies.

Nickel Disposals

An agreement has been made by the Board of Trade with the Mond Nickel Company, Limited, under which the latter will offer for sale, as agents of the Board, 1,600 tons of nickel pellets from the strategic reserves held by the Board.

Sales will be made for consumption in the United Kingdom at the Mond Nickel Company's normal selling price and will, as far as possible, be spread over the period September, 1957, to June, 1958, inclusive. The Mond Nickel Company will offer 500 tons for distribution in the near future.

Engineering and Marine Exhibition

The 1957 Engineering, Marine, Welding and Nuclear Energy Exhibition (to give it this year's full title) is to be held at Olympia, London, from August 29 to September 12, inclusive. It is to be open week-days from 10 a.m. to 6 p.m., except Fridays, when it closes at 8 p.m. Covering more than 250,000 sq. ft., the space is to be occupied by more than 500 exhibitors displaying thousands of products. Sponsoring organizations include the British Acetylene Association; British Electrical & Allied Manufacturers' Association; British Engineers' Association; Institute of Welding; Nuclear Energy Trade Associations Conference, and the Society of Motor Manufacturers & Traders, Limited (Marine Section). The following paragraphs give brief details of a few of the exhibits that may be of interest to foundrymen. (It should be borne in mind that this bi-annual exhibition includes, every fourth year, a section devoted to foundry supplies and equipment; the last of this type being held in September, 1955. This year, although castings are featured on a great many stands and a number of foundry firms are exhibiting individually, there is no special section or emphasis placed on foundrywork.)

A.P.V.-PARAMOUNT, LIMITED—(*stand* 11, *row K, Grand hall*) are to exhibit cast components in the finished and part-machined condition, including a three bladed 5-ft. dia. marine propeller, petroleum-valve parts, chemical-pump casings and impellers in a variety of stainless-alloy steels.

ATLAS COPCO (GREAT BRITAIN), LIMITED (*stand* 4, *row R, ground floor, National hall*) will be showing a comprehensive range of engineers' tools and pneumatic equipment for marine use; being shown for the first time are the MLT 11KR air hoist, the LBK 31 pneumatic shear and the LBV 32 corner drill.

BATES & BATES, LIMITED—(*stand b, row Y*) are to exhibit a new hydraulic ram of 1¾-in. outside dia., with a 3-in. forked lug at one end for mounting purposes. The ram is non rotating and has a single acting movement with internal spring return. The smallest piston size is ½-sq. in., and the maximum working pressure is said to be 2,000 lb. per sq. in.

BIRLEC LIMITED (*stand* 14, *row E, ground floor, Grand hall*) are to demonstrate the recently introduced "Ajaxomatic" melting unit in operation with an aluminium die-casting machine, also the sealed quench furnace, for clean heat-treatment in a wide variety of applications.

BRITISH OXYGEN GASES, LIMITED (*stand* 1, *row W, Empire hall*) are to display a range of equipment and processes, illustrating the latest developments in gas welding and cutting; these include the "Argonarc" process, and "Argonaut" equipment, applicable to welding light-alloy castings.

BRITISH ROTOTHERM COMPANY, LIMITED (*stand* 16, *inner row, gallery, Grand hall*) are to show a range of their equipment under the following headings: Bi-metal instruments; mercury-in-steel thermometers, recorders and controllers; vapour-pressure thermometers; pressure recorders, and pressure gauges.

BRUSH GROUP (*stand* 5, *rows O and P, ground floor, National hall*)—Brush Electrical Engineering Company, Limited are to display a range of gas-turbines, for use with single or multiple units of gasifiers, together with a turbocharger for diesel engines; a salient-pole alternator; an electronic high-speed precision tachometer, and a portable vibration indicator. J. & H. McLaren, Limited—are to exhibit their "LE" range of high-speed, lightweight diesel engines, the "Petter McLaren PD4M" marine-propulsion engine, and the auxiliary generator set. Mirrlees, Bickerton & Day, Limited—will show their "KVSS12" engine, developing some 3,100 h.p. at 428 r.p.m. National Gas & Oil Engine Company, Limited—will feature the "GS.34" free-piston gasifier, which is manufactured under licence from Alan Muntz & Company, Limited; this is claimed to be one of the first British built models of 1,232 gas h.p. The company are also showing the National NM series of engines. Petters, Limited—will be showing two PC engines from an entirely new range of lightweight high-speed aircooled diesel engines, for automotive, agricultural or industrial applications.

BRYCE BERGER, LIMITED—(*stand* 32, *outer row, gallery, National hall*) are to show an engine-speed control unit which operates on an entirely new principle. Called the "Speedlock," the unit provides accurate control of most engines within the 500 to 5,000 hp range. It is hydraulically connected to a remotely-driven gear pump and can be situated in any convenient location.

DALLOW LAMBERT & COMPANY, LIMITED—(*stand* 3, *row Z, ground floor, Empire hall*) are to feature a range of industrial dust-control equipment, including wet-dusters; dry-tube filters; cyclones, and the "Dustmaster" and "Drytex" unit dust collectors.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH (*stand* 3, *row K, ground floor, Grand hall*) will exhibit developments and results of investigations carried out by the mechanical engineering research and National Physical laboratories, together with those of the British Iron and Steel Research Association, British Non-Ferrous Metals Research Association and the British Shipbuilding Research Association.

DUNLOP RUBBER COMPANY, LIMITED—(*stand* 9, *row D, ground floor, Grand hall*) are to display a range of their products including "Duthane," a new synthetic rubber; "Maxrate" V-belting, incorporating terylene cording; conveyor and elevator belts, with emphasis on heat-resisting types; oil-suction and discharge hose, and flexible hose in high, medium, and low-pressure ranges for supply lines.

THE GAS COUNCIL—(*stand* 5, *row N, ground floor, National hall*) are to demonstrate the "Equiverse system" of furnace control, devised by the Incandescent Heat Company, Limited, incorporating a novel thermal cycle, which can be applied to existing or new furnaces covering a range from 750 to 1,300 deg. C., together with a new coke-fired furnace, capable of supplying clean heating gases at temperatures up to 1,250 deg. C.

HOLMAN BROTHERS, LIMITED—(*stand* 4, *row DD, first floor, Empire hall*) are to demonstrate the important position of compressed air, in all forms of engineering. Included in the display are stationary and portable compressors. and a wide range of general-purpose pneumatic tools. The company are also to show the latest "Dustuctor" developments of the low-volume, high-velocity system of dust control which will be of special interest to all foundrymen.

JOHN THOMPSON, LIMITED—(*stand* 4, *row F, ground floor, Grand hall*) are to feature a combined display of the Groups' products, including the "Unipac" boiler, a fully automatic, oil-fired, self-contained unit; a model of a shell boiler, which has been used to observe water-level conditions during operation; water-tube boilers, and developments in nuclear engineering field.

KEITH BLACKMAN, LIMITED—(*stand* 1, *row A, ground floor, Grand hall*) will display a comprehensive range of products including the following items: A 75-in. dia. centrifugal fan/impeller; hydro-rotor filters; a 33-in. dia. pivot-roller axial fan; a 10-in. dia. induced-draught and grit arrestor fan; multi-tubular dust-collectors; industrial gas equipment; a four-way fume-exhaust unit; the "Cupodel" hot-blast cupola plant, this exhibit comprising a scale model of a typical installation, and a "Tornado" shot-cleaning unit (demonstrated by means of a working scale-model).

LANCASHIRE DYNAMO GROUP—(*stand* 8, *row P, ground floor, National hall*) will feature photographs showing a wide range of products manufactured within the network of the group, comprising examples of motors, generators, transformers, industrial electronic equipment, rectifiers, test equipment, voltage-regulating equipment and switchgear.

MOND NICKEL COMPANY—(*stand* 2, *row G, ground floor, Grand hall*) will demonstrate how many engineering difficulties can be solved by the correct selection of constructional materials; subjects covered will include corrosion resistance, physical properties and weldability of metals. Materials, including s.-g. iron and many other nickel-containing alloys will be on display, and a wide range of the company's publications will be available.

MUREX, LIMITED—(*stand* 3, *row E, ground floor, Grand hall*) are to show many new products including electrodes, transformers, a new automatic-welding machine, and welding accessories.

NORTHERN ALUMINIUM COMPANY, LIMITED—(*stand* 1, *row BB, first floor, Empire hall*) are to give prominence to the applications of "Noral" aluminium in the nuclear-energy and ship-building fields, together with the growing contribution to general engineering that the company's new production equipment is making.

PLUS GAS COMPANY, LIMITED—(*stands* 1 *and* 2, *centre row, gallery, National hall*) will be introducing a new product, a tannating process for the preparation of metal surfaces prior to painting. This material forms a tannate/gamma-ferric oxide complex by the reactions of the tannins with oxides on the metal surfaces, thus creating an insoluble corrosion-resisting film. This film, it is claimed, affords an excellent bond for other protective coatings as it does not chip, being an integral part of the metal surface.

QUASI-ARC, LIMITED—(*stand* 5, *row W, ground floor*) are to show a number of new complete welding installations together with the full range of "Fusarc" and "Unionmelt" automatic welding heads (both stationary and self-propelled). Also on view will be a model of the new Girth seam welder for the automatic welding of large storage tanks; a section of the internal-welding boom which incorporates television equipment used to guide the welding head; the finger-type backing-bar jig, designed to facilitate the welding of longitudinal seams in material thicknesses ranging from 0.015 in. to 0·1 in.; the boiler end and flue welding machine; and the new motor-generator set, Type MGB.400, which has a rapid voltage recovery.

RUSTON & HORNSBY, LIMITED—(*stands* 13, *row A;* 10, *row E; and* 10, *row F, ground floor, Grand hall*) will show, for the first time, two additions to the company's field of gas-turbine and locomotive equipment. A new gas-turbine engine will be shown as a running exhibit, coupled to a generator, and specially housed in a viewing chamber, near the exit to Gate J.

SUFFOLK IRON FOUNDRY (1920), LIMITED—(*stand* 4, *row Y, ground floor, Empire hall*) will demonstrate the use of "Silfbronze" rings, with "Stanelco" automatic flame-brazing equipment, and the first appearance will be made of the new "Demon" cutting blowpipe.

TURNER MANUFACTURING COMPANY, LIMITED—(*stand* 1, *row S, ground floor, National hall*) are to show a range of products of their subsidiary company, Hydraulics & Pneumatics, Limited, including high-pressure, automatic variable-delivery pumps; gear pumps and selectors.

UNITED STEEL COMPANIES, LIMITED—(*stand* 7, *row N, ground floor, National hall*) will represent all the steelmaking branches of the company by examples of typical products; three ingot moulds will be shown by Distington Engineering Company, Limited.

G. & J. WEIR, LIMITED—(*stand* 3, *row F, ground floor, Grand hall*) are to display a large range of their products, including an evaporator, horizontal-geared turbine, air-compressors and pumps, together with working models of the closed-feed system and two element boiler-feed controller.

Official Visits

The following official visits will be made during the exhibition, on the dates quoted:

Friday, August 30
Iron & Steel Institute.

Monday, September 2
British Cast Iron Research Association; Council of Iron Foundry Associations; Foundry Trades' Equipment and Supplies Association, Limited; Joint Iron Council; Institute of British Foundrymen; Council of Iron Producers, and the Refractories Association of Great Britain.

Wednesday, September 4
National Society of Master Patternmakers.

Thursday, September 5
Institute of Metals.

Friday, September 6
Institution of Mechanical Engineers, and Purchasing Officers' Association.

Wednesday, September 11
Institute of Vitreous Enamellers, and the Worshipful Company of Founders.

Changes of Name

Among companies which have recently changed their names are those listed below. The new titles are given in parentheses.

C. W. MORGAN, LIMITED, Mill House, Magor, Mon (Magor Engineers & Contractors, Limited).

JAMES HOLT ENGS. (SALES), LIMITED, Milton Works, Mule Street, Bolton (James Holt (Engineers), Limited).

VALVOPOINT ENGINEERING COMPANY, LIMITED, 20, Roxborough Road, Harrow, Middx (Sedan Products, Limited).

JAMES HOLT (ENGINEERS), LIMITED, Milton Works, Mule Street, Bolton (James Holt Engs. (Sales), Limited).

K. B. L. PRODUCTS, LIMITED, ironfounders, etc., of Brockhurst Works, Bescot, Walsall (Coated Strip, Limited).

HITHERFIELD (LONDON), LIMITED, machinery, etc., of 20, Bloomsbury Square, London, W.C.1 (Lerner (Sales), Limited).

BYWORTH CASTINGS, LIMITED, ironfounders, etc., of Albion Works, Dalton Lane, Keighley, Yorks (Hector Moore, Limited).

WILLIAM BATES SON & COMPANY, LIMITED, engineers, etc., of Imperial House, Dominion Street, London, E.6 (W. B. (Investments), Limited).

Company News

JAMES BOOTH & COMPANY, LIMITED, non-ferrous metal manufacturers, of Birmingham—The directors have decided to accept in principle the offer recently made by the Delta Metal Company, Limited, for the ordinary share capital in respect of their own holdings.

UNITED FIRECLAY PRODUCTS, LIMITED, Glasgow—The offer of the Woodall-Duckham Construction Company, Limited, to acquire the ordinary capital of the company (conditional upon 90 per cent. acceptance) has been accepted in respect of almost 89 per cent. of the capital. For holders who have not as yet accepted, the offer is extended until August 26.

STEEL COMPANY OF WALES, LIMITED—An interim dividend of 2½ per cent. is declared by the company on account of the year ending September 28. This is as forecast in the March offer for sale of £40,000,000 ordinary shares. Operations for the year to date are stated to indicate a higher profit level than the £16,000,000 forecast with the offer and, subject to unforeseen circumstances, it is intended to pay a 3½ per cent. final, as indicated in the prospectus. As previously stated, the aggregate of these dividends would represent a rate of approximately 8 per cent. on the average of the paid-up capital.

GEORGE KENT, LIMITED, engineers and industrial instrument manufacturers, of Luton—Turnover for the year to March 30, 1957, increased by £400,000 to £5,465,000. Group trading profit was £648,474, against £541,482 for 1955-56, plus £1,688 investment income (£997 and £15,000 tax over-provided). After depreciation, pensions, minority interest, and tax, etc., net profit was £160,946 (£161,423). The chairman, Cmndr. P. W. Kent, says capacity was redeployed and the greater quantities of standard instruments despatched reduced the volume of orders and enabled better deliveries.

STOTHERT & PITT, LIMITED, engineers and iron-founders, etc., of Bath—The proposed one-for-two scrip issue is to be put into effect at an extra-ordinary meeting on August 29. It is proposed to capitalize £500,000 from capital reserve for the issue of £1 ordinary shares to holders at August 21. Authorized capital is to be raised to £2,000,000 by the creation of 750,000 £1 ordinary shares which will leave 400,000 unissued after the capitalization. The new shares will not rank for any further dividend that may be distributed in respect of the year to June 30, 1957, in which connection the directors emphasize that dividend policy for that and future years will naturally depend on results.

RANSOMES & RAPIER, LIMITED—Particulars are announced of an issue of £400,000 6 per cent. second mortgage debenture stock, 1980-85. The stock was placed by Securities Agency in conjunction with Cazenove & Company, at 95 for payment in full on August 15. At the same time, the £150,000 4½ per cent. second mortgage debenture stock 1980-85 placed in 1955 has been converted into 6 per cent. stock as from August 9. Application is being made for a quotation for the total issue of £550,000 stock. The proceeds of the present issue, estimated at £373,500, will be applied partly for building and equipping a new shop to be used for constructing large walking draglines and partly for financing additional work in progress. The gross annual amount needed to meet the interest on the 3½ per cent. first and the 6 per cent. second mortgage debenture stocks will be £38,900, covered more than five and a quarter times by average profits of four years to end-1956.

New Patents

(Copies of complete specifications are obtainable from the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2, price 3s. 6d.)

776,283. United States Steel Corporation, 525, William Penn Place, Pittsburgh, 30, Pennsylvania, USA.

Production of fully-killed steels having the characteristics of rimmed steels. In particular the invention concerns austenitic-chromium-manganese, fully-killed steels having improved qualities resulting from the evolution of gas therefrom after teeming.

776,285. Low Moor Alloy Steelworks, Limited, Low Moor, Bradford, Yorks.

The continuous casting of steel, or other metal, by a process which involves introducing the molten metal into one end of an open-ended, tubular mould and withdrawing it at the other. In the present invention the movement of the mould in response to the pull exerted upon it by the withdrawal of the cast bar is opposed by pneumatic or hydraulic pressure.

776,315. Union Carbide and Carbon Corporation, 30, East 42nd Street, New York, USA.

Desulphurization of cast iron to below 0.01 per cent. A quantity of calcium carbide entrained in a stream of gas is injected into the molten cast iron. Prior to this injection a deoxidizer, such as calcium/silicon/aluminium or ferro/silicon is added to the cast iron in the proportion of 2 lb. (0.9 kg.) per ton of cast iron.

776,649. United Kingdom Atomic Energy Authority, London.

Magnesium-alloys of high-magnesium content which are resistant to the effect of air or oxidizing gases, particularly at elevated temperatures approaching the melting point of the alloy.

776,809. Society D'Inventions Aeronautiques et Mecaniques (SIAM), 1 Route des Alpes, Fribourg, Switzerland.

Production of alloys of magnesium and rare earths which contain zirconium in addition. (See also Patent No. 761,324, FOUNDRY TRADE JOURNAL, January 3.) The composition in this new patent is slightly different, *viz.* rare-earth metals 2 to 6, zirconium 0.01 to 0.005 per cent. Magnesium constitutes the remainder. The rare-earth metals contain, in the final alloy, lanthanum 25 to 35, praseodymium 8 to 12, cerium 2 to 10, samarium 0.5, and neodymium 40 to 65 per cent.

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained. Details of tenders with the reference ESB can be obtained from the Board of Trade Export Services Branch, Lacon House, Theobalds Road, London, W.C.1 (telephone: CHAncery 4411, ext. 738 or 771), unless otherwise stated.

ASHBY-DE-LA-ZOUCH, September 4—Cast-iron foul sewers, manholes, together with 600 yd. of 5-in. dia. cast-iron pumping main. Deposit £2 2s. Documents from Pick Everard, Keay and Gimson, 6, Millstone Lane, Leicester.

IRAQ, September 21—Cast-iron tees, bends, reducers, split collars, flange and caps for asbestos-cement pipes. (ESB/19609/57.)

IRAQ, November 5—Air-conditioning installation for Sirwan hotel premises. (ESB/19608/57.)

RHODESIA AND NYASALAND, August 29—Automatic shaping woodworking machine for the Federal Tender Board. (ESB/19858/57.)

SOUTH AFRICA—Export opportunities exist for light-engineering products, nuclear-energy power plants and railway equipment. (ESB/18624/57.)

SOUTHEND-ON-SEA, August 22—Three-and-a-half miles of spun-iron sludge-pumping main and incidental works. Deposit £2. Documents from Borough Engineer and Surveyor, Municipal Buildings, Southend-on-Sea.

VIETNAM, September 4—5-h.p. outboard motors for the International Co-operation Administration Procurement for Vietnam. (ESB/19499/57/ICA.)

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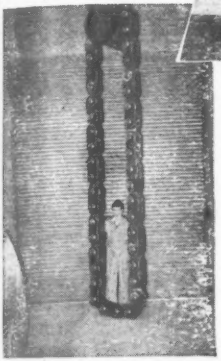

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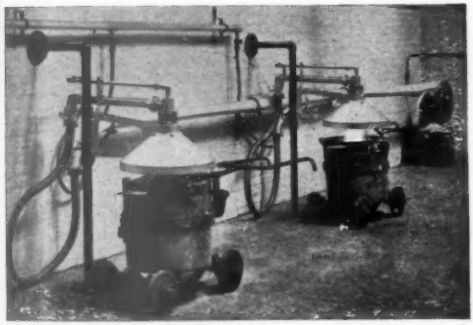

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News in Brief

THE SIXTH FACTORY EQUIPMENT EXHIBITION is to be held at Earls Court, London, April 14 to 19, 1958.

THE Federation of Light Metal Smelters announces that its members' average selling prices for June, calculated to the nearest 10s., were:—LM1, £158 10s. per ton; LM2, £159; LM4, £182 10s.; LM6, £202 10s.

ORDERS for a further 10 power equipments for main-line diesel-electric locomotives; 69 sleeping cars; 400 containers of 4-tons capacity, and 150 ballast wagons, are among the contracts announced by the British Transport Commission, as part of British Railways modernization plan.

SAMUEL FOX & COMPANY, LIMITED, Stocksbridge, Sheffield, are building a new chemical laboratory in stainless steel. The curtain walling is formed of stainless steel in diamond-embossed panels, which are bonded to an insulated core and fastened to a grid frame by an all-dry glazing technique.

THE BATTERSEA COLLEGE OF TECHNOLOGY is organizing a series of lectures, commencing September 24, on the subject of the "Selection of Engineering Materials." The lecture to cover the "Selection of Materials for Casting" is to be given by Mr. J. B. McIntyre, of the National Foundry College, on Tuesday, October 22.

WEST GERMANY has reduced most of its industrial tariffs by 25 per cent., for the period August 20 to December 31, 1957. Coal and steel are excepted and there are important exceptions, covering 123 industrial items in 40 groups. The position will be reviewed at the end of the year. Within little over a year, maximum German tariff rates have been cut from 35 to 16 per cent.

BRITISH MOULDING MACHINE COMPANY, LIMITED, Faversham, Kent, have just completed the production of a 16 mm. colour film (sound) dealing with automatic moulding machines. This film which is approximately 300 ft. in length, carries no advertising other than the initial credit of origin. It is available for showing to technical audiences on written application to Faversham.

A "LITTLE MESTER'S" WORKSHOP has been removed from St. Philip's Road, Sheffield, and reconstructed in the city's Weston Park museum. It was given by Mr. Tom Merrill, one of the city's few remaining old craftsmen, and is complete with bellows, fireplace, and tools. It is a hand-forger's shop for making knife handles and is over 100 years old. Next to it in the museum is being built a reproduction of a hand filecutter's workshop.

GUESTS of the Yale & Towne Manufacturing Company's British Divisions, during this week are the Mayor and Mayoress of Folkestone, Councillor and Mrs. L. Fowler. Earlier in his career Councillor Fowler was a member of the company's sales staff. There is to be a luncheon at the Victoria Hotel, Wolverhampton, to-day, at which the Mayor of Wolverhampton will also be present with other civic officials and local industrialists.

DUE TO the expansion of its business in Belgium, George Kent, Limited, Luton, has formed a new company, Kent Continental S.A., with headquarters at 82, Chaussée de Charleroi, Brussels. The new company comprises a sales, engineering, and service organization covering the full range of Kent products, fully staffed by engineers trained by the parent company. There is a well-equipped workshop and a comprehensive stock of spare parts is held.

THE SIXTH ANNUAL CONFERENCE on problems of aircraft production, promoted by the Southampton section of the Institution of Production Engineers, will again be held at the University of Southampton on January 2 and 3, 1958. The theme will be: "US and UK Practice." The conference will be opened by the presentation of the third Lord Sempill paper, which will be given by Mr. Boyd K. Bucey, assistant to vice-president-manufacturing, the Boeing Airplane Company.

SELSDON MACHINE TOOL COMPANY, LIMITED report that many of their principals, for whom they act as UK agents, will be exhibiting a range of their products at the forthcoming European Machine Tool Exhibition, to be held in Hanover from September 15 to 24. The exhibits will include a semi-automatic cold-tube bending machine; a movable-column milling machine; a plano milling machine; a centreless grinding machine; a guillotine shear; production lathe, and universal drilling machinery.

THE INSTITUTION OF PRODUCTION ENGINEERS announce that the annual dinner will be held on Friday, October 4, at the Dorchester Hotel, London. The principal guest will be Sir John Maud, G.C.B., C.B.E., Secretary, Ministry of Power. Tickets, price £3 5s. each, may be obtained from the secretary of the Institution at 10, Chesterfield Street, London, W.1, but it should be noted that applications will be dealt with in strict order of receipt and will not, in any case, be accepted after September 18.

THE FIRST SMOKELESS HOUSE of the East Midlands was opened on August 9, by the Lord Mayor of Sheffield, Alderman A. Ballard. It is an old, terrace-type house, which has been fitted with the latest gas fires and kitchen equipment, the conversion being carried out by the East Midlands Gas Board and the owner, Mr. F. Coldwell. A 50 per cent. grant under the Housing Repairs and Rent Act of 1954 was provided by the City Council. The house, at 15, Holland Place, Highfield, Sheffield, is open for public inspection until September 4.

A NEW STATUE of Josiah Wedgwood is to be erected outside the Wedgwood works at Barlaston, in the autumn. The statue has been cast in bronze by Corinthian Bronze Company, Limited, of Peckham, and shows the upright figure of Josiah, holding his famous copy of the Portland Vase. The moulds of the original statue are being used; they had lain in pieces since 1863 in a Stoke-on-Trent scrap yard and were only recently discovered by workmen. The pieces were rescued, transported to the Wedgwood factory and remodelled by the company's head modeller, Eric Owen.

SPEAR & JACKSON, LIMITED, Savile Street, Sheffield, have moved their machine-knife department into new £300,000 premises across the road. When the men returned after their holiday, on August 12, they found the 70 pieces of machinery weighing over 150 tons, and 100 tons of stock set up in the newly opened shop with 17,500 sq. ft. of area, instead of the 15 separate workshops a century old. Two further storeys above the machine-knife shop will be brought progressively into use—one for warehousing and the other for a new segmental saw department. The Lord Mayor of Sheffield, Alderman A. Ballard, will officially open the new premises in September.

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Personal

Mr. F. B. McPHERSON has been elected a director of the Glacier Metal Company, Limited, Kilmarnock.

Mr. R. HALLIWELL, formerly on the staff of Thos. W. Ward, Limited, is now a representative in the rail department of S. Rhodes & Company, Limited, Sheffield.

Mr. S. PIENAAR who has been elected president of the South African branch of the Institute of British Foundrymen, is works manager of African Malleable Foundries, Limited.

Mr. A. M. A. MAJENDIE, M.A., A.F.R.AE.S., F.I.N., and Mr. L. C. HARMAN have been appointed to the board of Smiths Aircraft Instruments, Limited. Their appointments took effect from August 1.

Mr. JOHN R. LEIGHTON has joined the board of Prince-Smith & Stells, Limited, makers of textile machinery, Keighley, in succession to the late Mr. L. FEATHERSTONE, with effect from August 13.

Mr. EDMUND B. BALL has been appointed managing director of the Lilleshall Company, Limited, and its subsidiaries in succession to the late Mr. ALEXANDER OXLEY. Mr. Ball will take up his duties on October 1.

Mr. T. BRIERLEY, foreman patternmaker for Bentley & Jackson, Limited, paper-machinery manufacturers, Lodge Bank Works, Bury, Lancashire, has been presented with a gift by the directors on his retirement after 38 years' service.

Mr. L. WEBSTER has been appointed production manager (engineering) of Distington Engineering Company, Limited, a subsidiary of the United Steel Companies, Limited, and Mr. COLIN SCOTT has been appointed personnel manager.

Mr. E. VERNON MAYER, a director of Edward Curran Engineering, Limited, Cardiff, has been elected a member of the Council of the Industrial Association of Wales and Monmouthshire. He has been a member of the Association's South Wales Executive Committee since 1947 and is also a member of the Finance Committee.

Mr. G. B. PARTRIDGE, who until recently was employed as chief metallurgist, Elektron Foundries, with the Birmingham Aluminium Casting (1903) Company, Limited, Smethwick, has now joined William Mills Limited, Wednesbury, where he has been appointed to the position of development officer, as from August 1.

Mr. W. D. RENNIE, the chief accountant of the de Havilland Aircraft Company, Limited, has been appointed secretary of the company. In 1950 he joined the de Havilland Engine Company, Limited, and served as chief accountant until early in 1956, when he transferred, in the same capacity, to de Havilland Aircraft.

Mr. A. H. NORRIS, assistant works manager (production) of John Lysaghts Scunthorpe Works, Limited, has been appointed president of the Lincolnshire Iron and Steel Institute in succession to Mr. CEDRIC THOMAS, who resigned in June. Mr. Thomas was formerly general manager at the Redbourn Steelworks, Scunthorpe, of Richard Thomas & Baldwins, Limited; his successor, Mr. W. O. CAMPBELL ADAMSON, has been elected a vice-president of the Institute.

Mr. RUSSELL H. BROWN, B.SC., A.I.M., has joined the research staff of the British Steel Castings Research Association as a senior investigator in the plant engineering section. After graduating at Durham University, Mr. Brown was for three years a research metallurgist in the Brown-Firth Research Laboratories, Sheffield, and in 1954 was appointed assistant to the technical manager of James Neill & Company (Sheffield), Limited, being responsible for the foundry and heat-treatment departments.

Mr. T. R. TWIGGER has been appointed to the board of the British Piston Ring Company, Limited, and to those of its subsidiary companies Bricovmo Limited, and British Aero Components Limited. Mr. Twigger, who was educated at Bablake School and Birmingham Central Technical College, joined the firm in 1916 as junior chemist and, apart from service in the R.A.F., has served it continuously. At present he holds the position of chief research engineer and metallurgist. He is an associate member of the Institution of Mechanical Engineers, a fellow of the Institution of Metallurgists, and a member of the Iron and Steel Institute, and has been very active in the affairs of the British Cast Iron Research Association and the Institute of British Foundrymen. The last named Institute recently awarded him the Oliver Stubbs gold medal for technical services to the industry.

Obituary

The death is announced in the American Press of Mr. BENJAMIN FULLER at the age of 93. He was oldest past-president of the American Foundrymen's Society. For 30 years he was connected with the foundry activities of the Westinghouse Electric Corporation.

The South African Press announces the death of Mr. D. M. DAVIDSON, at the age of 74. He was for many years chairman and managing director of the East Rand Engineering Company, Limited, of Johannesburg, and was a director of the City Engineering Works, Limited, Pretoria, and of Meehanite (Africa) Pty, Limited.

After a long and distinguished career in marine engineering, Mr. RONAL BROWN, deputy chairman and managing director since 1950 of Scotts' Shipbuilding and Engineering Company, Limited, Greenock, died on August 12. He was 66. Mr. Brown, who had been associated with the firm for 47 years, was educated at Glasgow University, serving his apprenticeship with Scotts'.

Board Changes

MONSANTO CHEMICALS, LIMITED.—Mr. W. M. Thompson has resigned from the board.

COCHRAN & COMPANY, ANNAN, LIMITED—Mr. R. B. Lamb, a director and general manager, has been appointed managing director in succession to the late Mr. R. R. Stokes.

FOSTER, YATES & THOM, LIMITED—Following the acquisition of the issued capital of the company by Hick, Hargreaves & Company, Limited, Mr. W. D'Arcy Madden, Mr. Gilbert F. F. Davies, and Mr. John Aspinall, all directors of Hick, Hargreaves, have been appointed to the board. Major F. E. Hill, chairman of the company, has been appointed to the board of Hick, Hargreaves. All the directors of the company will be nominee directors for Hick, Hargreaves, which will eventually have a 100 per cent. holding of the company's issued share capital.

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Raw Material Markets

Iron and Steel

Most of the foundries have now returned to work after the annual holidays. As many consumers of castings were also closed during the foundrymen's holiday period, the state of the order-books shows little change. The engineering foundries continue to be the most active. Those supplying castings to the motor vehicle trade continue to receive regular business, which enables them to return good outputs, and castings for machine-tool makers, for the busy home trades, including steelworks, collieries, etc., electrical and power plant manufacturers, and general engineering trades are also called for on a good scale. The jobbing foundries are fairly busy, but the same cannot be said of the textile and light foundries. The latter, in particular, have had a long period of bad trade, and their prospects are not bright.

Low-phosphorus irons and hematite are being taken up in good quantities. Present demands absorb the major production of low-phosphorus irons, but hematite is more plentiful and producers could accommodate increased business without difficulty. Refined iron makers could also undertake increased business. High-phosphorus iron is plentiful, production exceeding the demand despite the fact that it has been reduced. Parcels of all grades of foundry pig-iron, hematite, and refined irons continue to be offered for the export market when licences can be obtained, and this is assisting producers in reducing their stocks. The major production of pig-iron continues to be obtained in basic pig-iron for the steelworks; they are accepting all available tonnages.

The scrap market has been quiet on account of holidays. Foundries are fairly well supplied and their needs comprise mostly the better and heavier grades of cast-iron and machinery scrap. Foundry coke is available in adequate quantities, except, may be, for some of the Welsh grades, while ganister, limestone, and firebricks can be obtained promptly.

Outputs at the re-rollers continue to be affected by holidays and this position is likely to extend until the end of the month. Although orders now being placed are not so heavy as they were, fairly good order-books are on hand. Demand for steel semis has been on a lower scale on account of holidays, but, as normal operations are resumed, demands are expected to increase. Home steelworks are able to offer supplies at the improved levels, which provides a continuity in deliveries.

Non-ferrous Metals

The Board of Trade announced on Tuesday that it will dispose of a further 27,000 tons of copper from the strategic reserve. No detailed plan as to method and rate of disposal can be announced until discussions have been held with Commonwealth producers and other trade representatives. The monthly rate of disposals is unlikely to exceed 2,700 tons. No copper will be offered for sale before October.

The *de facto* devaluation of the French franc last week, the rumours of a revaluation of the D-mark, and the weakness of sterling against both the dollar and the German mark have not only led to a flight of "hot money" from all over Europe into western Germany, but also to an improved demand for non-ferrous metals as a hedge against currency uncertainties. Accordingly, copper in London has been looking steadier and the price has advanced several points. This is a remarkable performance after the market having to readjust itself to the lower RST price of £210 a ton and the continually mounting stocks of refined metal in this country. The steadier tone in London has firmed up the US market, although business remains slow. US producers and custom smelters are maintaining their prices at 28½ cents and 28¼ cents a pound, respectively. However, the export price has dropped to 26½ cents and scrap to 22 cents a pound. Domestic copper stocks in the US in July were reported at 191,515 tons—the highest on record.

The feature of the tin market has been the establishment of a sizable contango and, with stocks in the UK continuing to pile up this is expected to continue. On the other hand, the re-entry of the Buffer Stock manager into the market could change the present position very quickly. Demand on both sides of the Atlantic is small, but the undertone is fairly good in both markets. In the US the price is fluctuating narrowly around 94½ cents a pound.

Lead is quiet on both sides of the Atlantic, although in America the offtake continues at a steady pace. The price remains unchanged at 14 cents a pound. Zinc is an improving market both here and in New York, where galvanizers are coming into the market for quantities of "Prime Western." Demand for special high grade is quiet. Consumption of slab zinc fell during May by 2 per cent. to 75,000 tons. The price is called 10 cents a pound for "Prime Western" zinc, East St. Louis.

With regard to the US Senate Finance Committee's hearing on the question of a sliding scale of import duties for lead and zinc, events took a surprising turn with the vote going in favour of a 3 cents per pound flat rate tariff increase on both lead and zinc. The Senate cannot initiate tariff legislation directly so that the Lead-Zinc Bill will have to go the House. General opinion is that no action will be taken this session.

Jobs Found for 28,000 in June

Unemployment is at a low level and there are now 332,000 jobs vacant and 244,000 people unemployed. During June, the Ministry of Labour states, the numbers in civil employment increased by 28,000 to 23,026,000, the main changes being seasonal in miscellaneous services. There were 332,000 unfilled vacancies on July 10, against 309,000 on June 12, and 397,000 in July last year.

The ratio of unemployed to the total working population is now down to 1.1 per cent., compared to 1.2 per cent. in June and 1.8 per cent. at the beginning of the year. At the peak of the 1955 boom the unemployment ratio dropped to 0.9 per cent. Employment in the vehicle trade rose by 1,000, but there were 1,400 fewer jobs in the aircraft industry, largely as a result of defence cuts. Among the bigger falls in numbers unemployed was engineering.

Italian Steel Output Record

An output record was set up in July by the Italian steel industry. Output amounted to 585,000 tons, against 521,000 tons in July, 1956. The previous record month was March this year, when 570,000 tons of steel was produced. Pig-iron output in July was 200,000 tons, compared with 189,000 tons in the corresponding month of last year.

During the first seven months of this year, 3,896,000 tons of steel and 1,227,000 tons of pig-iron were produced in Italy. During the same period last year 3,374,000 tons of steel and 1,079,000 tons of pig-iron were produced. Thus steel output this year is 15.5 per cent. up and pig-iron 13.7 per cent. up.

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Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered unless otherwise stated)

August 21, 1957

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £21 6s. 0d.; Birmingham, £20 18s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £23 17s. 0d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £24 1s. 3d.

Scotch Iron.—No. 3 foundry, £25 3s. 6d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £25 19s. 0d.; South Zone, £26 1s. 6d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £27 6s. 6d.; South Zone, £27 9s. 0d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. of England (local iron), £25 6s. 6d.; Scotland (Scotch iron), Zone S. 1, £25 13s. 0d.; Sheffield, £26 15s. 0d.; Birmingham, £27 4s. 0d.; Wales (Welsh iron), £25 6s. 6d.

Basic Pig-iron.—£20 3s. 0d., delivered Staffs, Derbyshire, Notts, Lincs, Rutland, Northants, and Leics.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered)

Ferro-silicon (6-ton lots and over).—45 per cent. Si, £50 0s. 0d. to £53 5s. 0d., scale 17s. 0d. to 17s. 6d. per unit; 75 per cent. Si, £70 0s. 0d. to £76 7s. 6d., scale 17s. 0d. to 17s. 6d. per unit.

Ferro-vanadium.—50/60 per cent., 28s. 6d. per lb. of V.

Ferro-molybdenum.—65/70 per cent., carbon-free, 12s. 6d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., 2-3 per cent. Cu, £250 0s. 0d.; 38/40 per cent., commercially carbon-free, £299 0s. 0d.

Ferro-tungsten.—80/85 per cent., 9s. 5d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 12s. 5d. per lb. of W.

Ferro-chrome (6-ton lots and over).—4/6 per cent. C, £96 0s. 0d. to £99 10s. 0d., basis 60 per cent. Cr, scale 33s. 0d. per unit; over 6 per cent. C, £94 0s. 0d., basis 60 per cent. Cr, scale 31s. 0d. to 33s. 0d. per unit; 2 per cent. C,* 2s. 2d. per lb. Cr.; 1 per cent. C,* 2s. 2½d. per lb. Cr; 0.15 per cent. C,* 2s. 3d. to 2s. 3½d. per lb. Cr; 0.10 per cent. C,* 2s. 3½d. to 2s. 3¾d. per lb. Cr; 0.06 per cent. C,* 2s. 3¾d. to 2s. 4d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 7s. 0d. to 7s. 6d. per lb.

Metallic Manganese.—90/92 per cent., carbon-free, £290 0s. 0d.; 96/98 per cent., £310 0s. 0d.

Ferro-columbium.—65/75 per cent., Nb + Ta, 22s. 0d. to 23s. 0d. per lb., Nb + Ta.

Ferro-manganese (home).—78 per cent., £87 19s. 3d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £33 1s. 6d.; tested, 0.08 to 0.33 per cent. C, £34 1s. 6d.; hard (0.41 to 0.60 per cent. C), £35 3s. 0d.; silico-manganese, £44 2s. 6d.; free-cutting, £37 5s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £41 7s. 0d.; silico-manganese, £44 10s. 0d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.33 per cent. C, £38 16s. 0d.; basic, hard, over 0.41 up to 0.60 per cent. C, £39 18s. 6d.; acid, up to 0.25 per cent. C, £43 10s. 0d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £42 12s. 0d.; boiler plates (N.-E. Coast), £45 2s. 0d.; floor plates (N.-E. Coast), £44 1s. 0d.; angles, N.-E. Coast, £40 6s. 6d.; joists, N.-E. Coast, £40 2s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., and flats, 5 in. wide and under, untested soft basic, 50 tons and over, £40 8s. 0d. (under 10 tons to 4 tons, £41 5s. 6d.; under 4 tons to 2 tons, £41 10s. 6d.); hoop and strip, coils, £40 10s. 0d.; uncoated strip mill coils, hot rolled, under 3mm. to 12g., £45 16s. 0d.; black sheets (hand mill), 24 g., £59 4s. 6d.; galvanized corrugated sheets, 24 g., £68 17s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £69 9s. 6d., nickel-chrome, £100 12s. 6d.; nickel-chrome-molybdenum, £112 16s. 6d.

NON-FERROUS METALS

Copper.—Cash, £209 15s. 0d. to £210 5s. 0d.; three months, £210 15s. 0d. to £211 0s. 0d.; settlement, £210 5s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 2s. 0¾d. per lb.; rods, 242s. 9d. per cwt. basis; 20 s.w.g., 276s. 0d. per cwt.

Tin.—Cash, £741 10s. 0d. to £742 0s. 0d.; three months, £743 0s. 0d. to £743 10s. 0d.; settlement, £742 0s. 0d.

Lead (Refined Pig).—Second half August, £93 0s. 0d. to £93 5s. 0d.; second half November, £93 0s. 0d. to £93 2s. 6d.

Zinc.—Second half August, £75 0s. 0d. to £75 10s. 0d.; second half November, £75 0s. 0d. to £75 10s. 0d.

Zinc Sheets, etc.—Sheets, 15g. and thicker, all English destinations, £109 15s. 0d.; rolled zinc (boiler plates), all English destinations, £107 10s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £90.

Brass Tubes, etc.—Solid-drawn tubes, 1s. 8½d. per lb.; rods, drawn, 2s. 11d.; sheets to 10 w.g., 180s. 3d. per cwt.; wire, 2s. 5½d.; rolled metal, 180s. 3d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), £147; B6 (85/15), — ; BS249, —.

Brass (High Tensile).—BS1400, HTB1 (30 tons), £199; HTB2 (38 tons), £211; HTB3 (48 tons), £227.

Gunmetal.—BS1400, LG2 (85/5/5/5), £184; LG3 (86/7/5/2), £195; G1 (88/10/2/½), — ; (88/10/2/1), £247.

Phosphor Bronze.—BS1400, PB1 (AID released), £266 per ton.

Phosphor Bronze Strip, etc.—Strip, 263s. 6d. per cwt.; sheets to 10 w.g., — per cwt.; wire, 3s. 9½d. per lb.; rods, 3s. 1½d.; tubes, 3s. 1½d.; chill cast bars: solids 3s. 1d., cored 3s. 2d. (CHARLES CLIFFORD, LIMITED.)

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 3s. 7½d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 0½d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 3s. 11½d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 5½d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £85 0s. 0d. to £87 0s. 0d. Nickel, £600 0s. 0d. Aluminium ingots, £197 0s. 0d.; aluminium bronze (BS1400), AB1, — ; AB2, — .

* Average 68-70 per cent.